Studies in Ecology and Sustainable Development

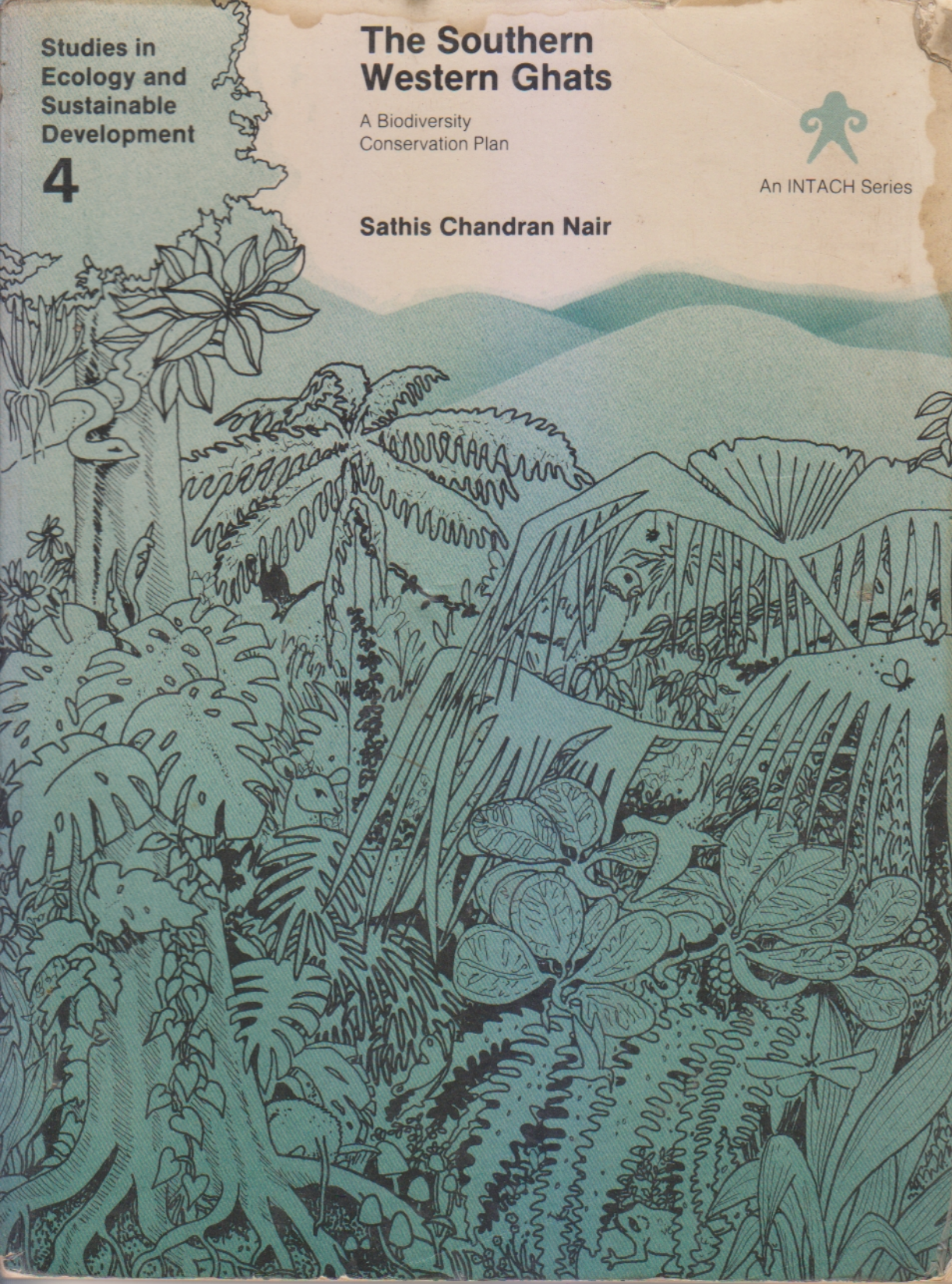
4

The Southern Western Ghats

A Biodiversity Conservation Plan

An INTACH Series

Sathis Chandran Nair



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by
Sathis Chandran Nair

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Contents

EDITORIAL

This is perhaps the most comprehensive study of the status of one of the country's three richest tropical moist forest areas, the southern Western Ghats of Kerala, the other two comprising the hill areas of north-eastern India and the Andaman and Nicobar Islands. For the author of this very valuable and timely research work Dr. Sathis Chandran Nair, it marks the culmination of a decade-long labour of love, wandering, with a naturalist-scientist's penetrating perception, through the maze of forests in almost every valley of the 500 km long range of the Western Ghats of Kerala. He is understandably concerned with the reckless destruction of some of our richest biological wealth over recent decades, and suggests what long-term conservation measures are critical for saving what is left of this treasure, most of which till today remains largely unknown.

India has some of the richest biodiversity in the world, ranging from the cold Arctic Zone of the Himalaya to the tropical humid areas of the southern Western Ghats, encompassing biotas from Africa, Europe, West Asia, North Asia, China and Malaysia from its unique location at their junction. And yet it has perhaps suffered the greatest impoverishment of its biota from human interference than any other region of comparable size. The rate of forest destruction continues at the staggering annual rate of 150,000 ha, threatening to turn this once lush green country into a lifeless brown desert in the not too distant future. We desperately need to reorder our priorities in favour of saving at all cost the few remaining natural climax forests which must still be abundantly stocked with unknown numbers of endemic species of inestimable value to future generations.

Dr. Nair has in this study drawn our attention to the rich floristic and faunal wealth of the Western Ghats which contain 27 per cent of the flowering plants of the country, and equally rich diversity and endemism in its faunal species. The richest assemblage of such species occurred in the 32 low elevation wet evergreen forest

valleys. Of these 12 valleys have been almost totally destroyed by irrigation and hydel reservoirs and power houses, while 7 valleys have lost all their natural vegetation to teak and eucalyptus plantations, and 4 wholly and 4 partly to encroachments and extensive agriculture. Only 8 valleys are left with some residual forests with nominal protection. If 'development' is extended to these valleys also, not much will be left to save of Kerala's rich biodiversity. The reduction in forest cover has also been extremely rapid.

Dr. Nair has recorded the status of the existing network of protected areas, including two national parks and 12 wildlife sanctuaries, which cover about 2,328 sq. km, but of which only 750 sq. kms represent intact and representative ecosystems. By realigning boundaries an additional 1200 sq. km of natural forests can be included in each of the different geographical segments of the southern Western Ghats for long-term conservation. It is unfortunate that, although the Nilgiri Biosphere Reserve, covering an area of 5,520 sq. km in the states of Kerala, Karnataka and Tamil Nadu, was the first to be launched in 1986 in India, not much headway has been made in implementing a practical and dynamic concept first enunciated by UNESCO as far back as in 1974.

We hope that this study of the sensitive and threatened tropical moist forest ecosystem of the southern Western Ghats of Kerala will be useful to the State Government, the Ministry of Environment and Forests and voluntary organisations in formulating action plans for urgently conserving some of our richest biodiversity before it is too late. We intend this to be a precursor to further such studies on our diverse and endangered ecosystems.

(N.D. Jayal)
Director (Natural Heritage)
INTACH

ACKNOWLEDGEMENTS

We are grateful to the Friedrich Naumann Foundation for their generous financial support which made this study possible.

The Friedrich Naumann Foundation of Germany is a non-profit making private institution, primarily engaged in the strengthening of democratic and pluralist developments, both in the industrialised and the developing world.

Formed after World War II, the Foundation is named after Friedrich Naumann, a well-known social-liberal stateman of the Weimar Republic. His vision of a liberal society was determined by his faith in the individual and his or her personal abilities. For Naumann, a self-reliant individual, aware and capable of sustaining his or her own rights, articulate and involved in the political process, was the liberal alternative for control and predetermination of the requirements of the state and social institutions.

In India the Friedrich Naumann Foundation is supporting projects in the field of environmental protection. One of its major partners is the Indian National Trust for Art and Cultural Heritage.

PREFACE

The all pervasive environment crisis has extended its reach and has started affecting adversely the daily existence of every human being on this planet. The seriousness of the crisis is no longer contested from any responsible quarters. Yet, an adequate response is lacking due to our own indifference, cynical unwillingness, incapability and, at times, ignorance. We human beings, the dominant species in the biosphere, have by our actions set in motion this process of environmental degradation which is now going beyond the tolerance limits for our own survival. Even our hesitant steps to tackle superficial problems are getting immobilized on confronting the magnitude of the problem and we constantly shy away from facing the core issues.

The hope that changes in the political system or marginal economic readjustments will solve our problems no longer sounds credible, nor is it acceptable to the weary common people caught in eddies of ever-increasing misery. Our dissonance with the natural processes is eliminating our capacity to identify the real causes, and wrecking our will to act for self-preservation.

A radical resetting of our current anthropocentric values, abandoning the present extremely short-term, selfish and material goals we have set for ourselves, and a total recasting of our economic, social, political and spiritual norms and institutions are necessary for us to get back our consonance with the natural rhythms and order. This alone will ultimately help us to sort out the chaos we have unleashed, and find an evolutionary destiny other than an early extinction.

All those who have realized this also understand that, even if we start now on the required course, there has to be a time lag before the corrective response can take effect. Due to the stereotypic behaviour of the human species, the inflexibility of our social systems and our own massive numbers, we need time before we can collectively perceive, assimilate and respond as required. There may be more unavoidable damage before that essential catharctic change. Whether the severity of the back-lashes set

off by the changes we have inflicted on our surroundings would give us the time to identify correctly our errors and start rectifying them is a moot point. We need hope in the end result to carry out the correct deeds, and faith in ourselves to do it. On the other hand, our highly evolved capacity of speech and our facility of communication through abstract signal cues, our social hierarchies and intricate cultural behaviour repertoires could help us to co-ordinate effectively and speedily our actions to save us also.

Optimistically speaking, we must have a strategy to minimise the damage we are inflicting now; we must accelerate the pace of the required change we have to undergo ourselves and then set about actively repairing the damage we have inflicted on our habitat as much as possible. Even if our corrective actions are but *adhoc* fire fighting measures only, we must still give priority to locations, the specific corrective actions decided by the ecological value of the area and the practical feasibility of our actions within the current socio-economic and political milieu. Preventing damage to life-support systems and curtailing the destruction and exhaustion of resources essential for our survival must be our first priority. Simultaneously, we must also evolve sustainable and socially just measures for using our limited resources. This, in other words, means redesigning current technologies and realigning the development of many basic disciplines of science. In almost every area there are too many of us with rapidly changing, unsustainable requirements.

This can be achieved only through redefining 'development', our current goal in all our endeavours. Our development must be long lasting. In other words, the manipulations of our environment must be ecologically viable. The modality of development must be distinctive for each specific region to suit the potentialities and limitations of that topographic unit. Developmental plans must be conceived with the natural or indigenous culture of each society as the matrix. The conduit of development must be retained institutionally to be as small and decentralized as possible for democratic and hence just functioing. These are some of the preconditions to make development ecologically harmonious.

These changes must happen globally and not only in isolation in a few locations. In each society, the specific measures to be adopted during each one of the many transitional steps to proper human welfare will be unique and hence there cannot be a universal blueprint suitable across dimensions of both time and space.

In our striving towards such a sustainable dependence on our environment, we have to adopt a range of measures, some globally co-ordinated, many nationally and locally collectively carried out and even some individual steps. Of this range of measures, perhaps what we have to adopt most urgently in India are steps to safeguard our invaluable and most essential resource—our tremendous potential for biomass generation. A corollary to it is our rich, traditional, culturally reinforced knowledge base and the spectrum of cultural mechanisms and social institutions evolved over

time to manage the resources competently. These also need to be protected in the face of externally influenced social change in the wrong direction.

The biomass potential of any region has two basic inter-dependent concrete components to it: (1) the potential of the climate, topography, water and soil of that region and (2) the living, evolving, genetic potential of the biota.

There is at present rapid forced change, erosion and irreversible loss of both the components in our country. Poverty in our country often starts and grows from biomass destruction or alienation. Forest protection is a crucial measure essential to arrest the loss, separately or simultaneously, of the physical environment and the biological potential which is the sum of the richness of our land. The only positive repair measure to be adopted, where natural production potential has been damaged is to help bring back natural plant communities (i.e. real afforestation).

Even where natural forests have survived, to implement direct and specific measures for their protection is no longer easy or effective due to the extensive damage and dilution our social institutions and administrative machinery have suffered. Historically, mutually irreconcilable interests have been built into our developmental policies. In particular with regard to policies for management of natural resources, we have not been able to identify and eliminate the colonial attitude of plunder for profit and replace it with policies for sustainable management. A thorough re-orienting of applied sciences dictating policies with regard to land, water and biological diversity is urgently needed in our country. The deepening social, economic and political crisis also adds to the difficulties in tackling the ecological crisis.

Considering the sheer difficulty of the problem and the limited time and resources that we have to tackle it, it is all the more essential to set pragmatic priorities for protecting and enriching our biological diversity, primarily forests. Protecting all remaining intact natural forest vegetation (which is only a small fraction of the available forest area with the government) is the first priority. Protecting totally all the remaining forests and aiding the expansion of forest vegetation cover over the ecologically fragile hill areas (which have wide ranging influences on all the biospheric processes) come next.

The humid tropical forests by their incomparable potential for biomass generation, their unique high genetic diversity and their extreme vulnerability to irreversible damage demand immediate attention and protection.

In the entire country, probably the most complex and species diversity-wise the richest vegetation assemblages are in the wet evergreen forests. Such vegetation is restricted mostly to north-eastern India, along the Western Ghats parallel to the south-western edge of the Peninsula, and in the Andaman and Nicobar Islands. Although the total extent of this forest type is more in north-eastern India and the minimally damaged more easily protected composite tracts are perhaps in the Andaman and Nicobar Islands, the biologically and biogeographically richest tracts are in the

southern Western Ghats south of 15°N latitude. These forests also have a more direct and tangible role in the survival and economic activities of a large segment of population in our country.

The very long period of uninterrupted geological stability of this part of the country, its past position in Gondwanaland and its current position so close to the equator, all have contributed to its rich genetic diversity. The characteristics of rock types in the Western Ghats deciding the soil characteristics, particularly topography and its shielding effect from the ingress of human civilizations, local micro and meso climatic conditions, etc. might also have a bearing on the exceptional richness of these forests.

The already extremely attenuated and fragmented forest belt in the southern Western Ghats is under maximum destructive pressure. This forest tract is also very difficult to insulate and protect surrounded as it is by large populations and their increasing needs. In the past, it had been ravaged by the European planters and subsequently for the plywood industry. Extensive monocrop industrial raw material plantations have been raised here irreversibly altering natural climax forest types. While the gentler plateaux such as the Nilgiris, Palnis (Kodaikanal Hills) and High Ranges were extensively cleared of forests, the more rugged and the less accessible segments of the southern Ghats were relatively less disturbed and retained the remaining better quality, more extensive climax evergreen forests at least till very recently. Then abruptly in the post-independence period, a whole combination of factors came to affect them calamitously. Developmental schemes, in particular river valley projects, roads, resettlement schemes, mining, industries, accelerated timber working and large-scale conversion of natural forests to the so-called fast growing commercial wood species, etc. caused massive damage. Moreover, population buildup in adjacent areas due to changed social and community health conditions led to the decimation of these last bastions of natural vegetation in the states of Karnataka, Tamil Nadu and Kerala.

Topographic location and climatic suitability have endowed the Western Ghat reaches in Kerala with the most luxuriant forests in the entire Peninsular India. In spite of an unparallelled record in forest destruction in recent times, this state has in its inaccessible reaches of the hilly tract the best remaining rainforests in the whole of peninsular India. The temporary safety of topography shielding them could be breached any time by engineering efforts, and hence all the more urgency for a concerted effort to save them.

In the overall national strategy to protect representative primary benchmark ecosystems and safeguard the genetic diversity our country is amply endowed with, the Kerala Western Ghat forests should occupy, along with the Andaman and Nicobar Islands, the highest priority. The first concrete step in extending effective protection to these areas is to identify the remaining intact forested tracts and to categorise them according to the status of intactness of vegetation. Viable units must be then selected and the intensity and specific nature of degradative pressures acting on each must

be identified. Evolving specific legal, administrative and developmental measures to counter these different pressures would be the next step. Integrating such real protective measures into viable, composite and pragmatic administrative programmes of action should follow thereafter. A democratic grassroot participatory institutional system to oversee the implementation of such programmes and carrying out post-implementation evaluations for the required mid-course corrections of such programmes are also required.

This brief report presents the results of a preliminary survey of forests in the Western Ghats of Kerala to identify locations for long-term protection as national heritage areas.

SUMMARY

The State of Kerala along the south-western extremity of peninsular India, by its location and topography, in particular the Western Ghat reaches, has its unique environmental characteristics. Within the state, there is a range of conditions, reflected in the variety of ecosystems. This brief summary presents outline information on the variety of forest ecosystems in the state which is an indicator of the biological diversity of the region and suggests measures for incorporating them into the existing network of protected areas.

Kerala's Western Ghats cover approximately an area of 20,000 sq.km, out of which administratively forest areas cover about 8000 sq.km. Intact climax forest ecosystems and representative areas of forest types, sub types, edaphic stages, etc. even in partially man-modified forms extend over approximately 2000 sq.km in nine geographically different locations. Even within some such locations, further fragmentation has taken place or is imminent.

The existing network of protected areas, i.e. national parks and sanctuaries cover about 2328 sq.km in two national parks and 12 wildlife sanctuaries. But intact and representative ecosystems extend over only about 750 sq.km of the national park, and sanctuary area. Some of the most invaluable areas are outside the protected area network. Excluding plantation areas, reservoir waterspread, pockets of tribal cultivation, etc. the total protected area in the state extending over 1900 sq.km is less than 5 percent of the geographical area of the state.

By realigning the boundaries of existing national parks and sanctuaries in each of the different geographical segments of the Western Ghats, the following areas can be set aside for long-term conservation in Kerala.

1. About 100 sq.km of intact areas in Agasthyamalai hill range along with the Chenduruny and Peppara sanctuaries.
2. About 500 sq.km of forest area in the Pandalam Hills along with the Periyar Tiger Reserve.

3. About 200 sq.km of representative ecosystems in a number of locations in the Kannan Devan Hills and Pooyankutty-Idamala Valleys along with the Eravikulam National Park and the Chinnar Wildlife Sanctuary.
4. About 200 sq.km in the Nelliampathy hills along with the Parambikulam-Chimmony sanctuaries.
5. As part of the Nilgiri Biosphere Reserve it is expected that about 450 sq.km of representative forest type areas and intact forest reaches would get protection in the Camel's Hump Mountains and western slopes of the Nilgiri adjoining the Silent Valley National Park and in the New Amarambalam Reserved Forest.

Along the western and northern edges of Wynad, there are about 200 sq.km of benchmark forest areas scattered in a number of locations. Located close to the Nilgiri Biosphere Reserve but outside it, they should be accurately identified and incorporated into the core of the biosphere reserve.

CHAPTER ONE

The Western Ghats : Mountains, Ecology and Human Welfare

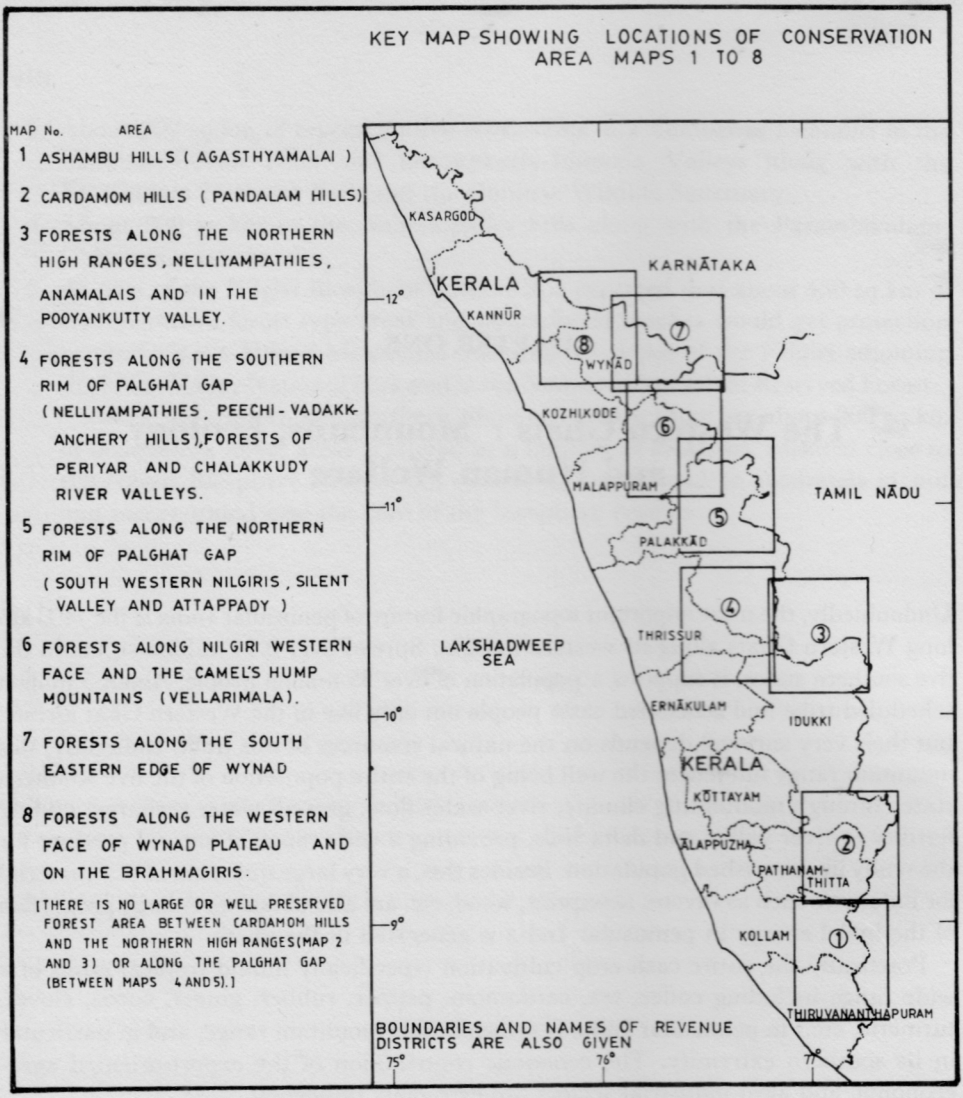
Undoubtedly, the most important topographic feature of peninsular India is the 1400 km long Western Ghats along its western margin. Spread over 0.14 million sq.km in the five southern states, it supports a population of over 35 million people. About 5 million scheduled tribe and scheduled caste people not only live in the Western Ghat forests, but their very survival depends on the natural resources of this tract. Indirectly, this mountain range influences the well being of the entire population of the five southern states through modulating climate, river water flow, ground water recharge, adding fertility to river valley and delta soils, providing a wide range of natural produce for the really impoverished population. Besides this, a very large quantum of raw material for industries such as rayons, newsprint, wood, etc. are also obtained. A large proportion of the hydel energy in peninsular India is generated in the ghats.

Practically the entire cash crop cultivation (specifically humid tropical crops of a wide range including coffee, tea, cardamom, pepper, rubber, ginger, cocoa, cloves, turmeric, etc.) in peninsular India is grown in this mountain range, and in particular in its southern extremity. The economic contribution of the export-oriented agro-economic and agro-industrial sectors are extremely important.

All coastal fisheries on the west coast depend on the nutrient discharge into the coastal seas and the subsequent marine productivity. The nutrients originate and are transported by rivers from the Western Ghats.

The complex topography and rugged terrain of the Western Ghats have provided refuge for a racially varied set of microcultures, ranging from the negrito groups to people like the Todas of the Nilgiris whose history remains a mystery. The very survival of these cultures is linked with the Western Ghats. This habitat, for them, is more than a resource base.

But the Western Ghats, along with most parts of the country, has sustained extreme



Some of the place names in Kerala have been officially changed recently. The maps and text may have either of the names :

Old	New
Trivandrum	*Thiruvananthapuram*
Quilon	*Kollam*
Cochin	*Kochi*
Trichur	*Thrissur*
Palghat	*Palakkad*
Calicut	*Kozhikode*
Cannanore	*Kannur*

environmental degradation. Being ecologically fragile, the damage has often been irreparable and disproportionately severe. The causative factors for degradation range widely from destruction of forests for commercial tree plantations, clearance of large tracts for cultivation, excessive cattle grazing and unsustainable cultivation practices leading to a total loss of the production potential of the land. More recently, extensive road construction (undermining the stability of the hill slopes), industrial mining, urbanisation, population pressure and excessive demand for the limited basic resources such as water, fuel, etc. are also leading to the total destruction of this hill range.

On the whole, age-old cultural practices which would have enabled the sustainable use of the total resource systems of the hills are being transplanted by alien means of 'development' causing widespread destruction.

Yet, surprisingly, the sheer terrainal inaccessibility has insulated many islands of original habitat and cultures against the destructive influences in this mountain fastness. The most untrammelled parts of peninsular India still remain in the southern Western Ghats. The continued survival of these facets of natural landscape and human cultures are facing the final onslaught of modern civilization, assisted by modern technology and the development of communication.

As a counter balance, concern about the degradation of these hills is spreading. But it is grossly inadequate to stem the tide of destruction. Equally alarming is that the healing touch yet remains to be applied on the vast areas damaged. This will decide the fate of millions in the years to come. In the overall gloomy scenario, perhaps the most urgent task is to identify and initiate quickly a whole range of measures to insulate and protect such regions and natural systems of outstanding value whose best use is not consumptive utilisation.

Lack of a proper understanding of what constitutes a sustainably utilisable resource, the absence of scientifically tested and proven methods of exploitation, and the lack of social institutions to manage the natural resources are the major drawbacks faced in natural resource management. Coventional models of development do not take into account the constraints and limitations of ecosystems. They also exclude the cultural antecedents of a society which alone enabled them to manage their habitat sustainably. Application of concepts and procedures which are often only exotic and theoretical frameworks result in the annihilation of the resource base and increase the instability of the human society dependent on that resource. Such a series of errors have cumulatively resulted in an unprecedented ecological crisis, particularly in the 'resource rich', fragile but 'backward' hill areas. Environmental problems in the Himalaya and the Western Ghats are, from the root cause of the malady, very similar.

The need to frame a strategy for the sustainable utilisation (which is conservation as distinct from preservation) of Western Ghats will not merely identify the resources to be protected but also spell out measures to guarantee and provide alternative

resources. Going further, such a strategy not only must lay down technically sound procedures for resource utilization, but also attempt to conceive practicable social, political and economic models for resource management, not in radical divergence with the current concepts, or institutions. Taking off from current reality, such models may attempt to transform into a viable alternative gradually.

Any conservation action plan has to deal with a natural unit of the habitat. The logical choice in this case is the ecosystem. Ecosystems form natural functional units in the organization of the living world. An ecosystem is often enough the highest level of organization wherein man can intervene for corrective action. Many ecosystems in the Western Ghats are extremely fragile, and so complex that, in fact we have not understood their dynamics. But once interfered with, such ecosystems get destabilized and go through a process of retrogressive changes which are irreversible. Hence a conservation plan for the Western Ghats automatically becomes an ecosystem conservation plan.

CHAPTER TWO

An Outline Plan for the Conservation of Biological Diversity in the Southern Western Ghats—An Introduction

In any natural heritage conservation effort in our country, the Western Ghats have an important place. This is not only because of the fact that this region retains relatively more of the biological wealth, but also due to the more direct interlinkage between the ecological and socio-economic factors existing here. The scientific requirement for preserving the genetic diversity of plants and animals and ecosystem models are almost abstract concepts in society. But the interrelation between ecology and human survival (for example, the stability of the hydrological cycle and vegetation cover) are far more tangible. That the forests in the heavy rainfall zone of the Western Ghats are of limited utility for timber production or that these forest lands are unsuitable for conversion to crop lands suggest logical possibilities in land use policy incorporating ecosystem preservation.

The southern Western Ghats has the best preserved and most extensive climax vegetation in peninsular India. Some of the tropical moist forests in southern Karnataka, Kerala and Tamil Nadu are among the best representative areas of Indo-Malayan rainforest formations. They have been severely fragmented and the relict pockets so reduced in area that at the current rate of degradation and conversion their chances of long-term survival are extremely bleak, unless immediate measures, qualitatively different from those currently used for forest protection, are evolved.

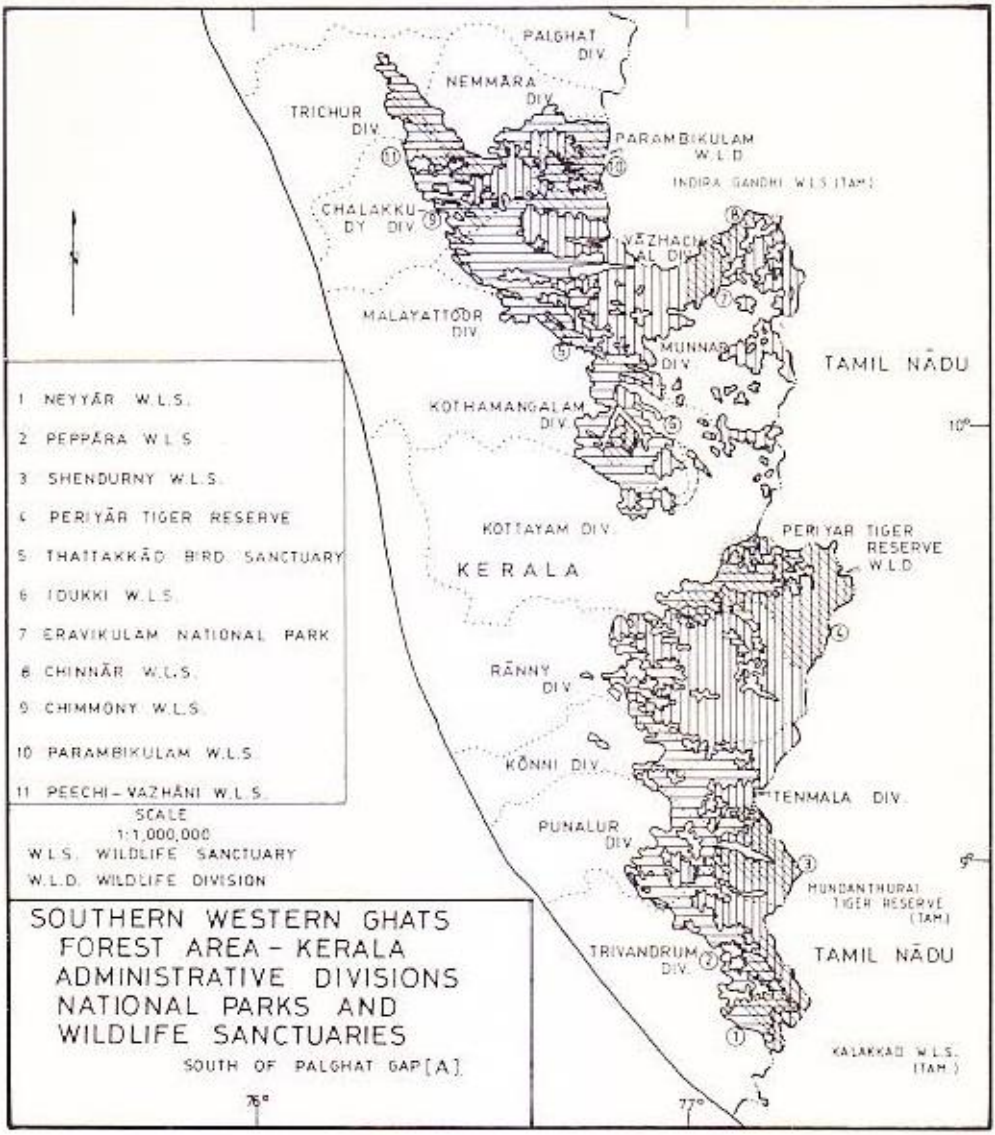
The strategy for conservation of any part of the biosphere should necessarily incorporate two components. One is to frame measures for effectively preserving representative areas, including natural as well as stable cultural landscapes. The second step is to evolve measures for sustainably utilizing natural resources, which range across social, cultural, economic, political, technical, legal and administrative steps. This, of course, is a task that demands time but is unavoidable.

Within the composite administrative and geopolitical unit of Kerala, an attempt is made to formulate a strategy which attempts to identify the most invaluable as well as endangered facet of the natural environment, and formulate measures which will help protect it.

The extension of modern agriculture, primarily cash crop cultivation, and the 'encroachment' of subsistence farmers occupying small holdings, over extensive areas of the ghats within a short time has eliminated the natural biological diversity in most of the settled parts. This leaves only the 'forest' area, administratively under the control of the state forest department. Here too significant portions of these reserved forests have lost their ecosystem diversity and stability and badly need restoration. But within the 'forest' area, there are isolated scattered remnants of the original extensive natural ecosystems. These areas have to be identified for special protection in a race against the relentless sweep of ecological degradation. Most of these ecosystems along with the species and most of the natural processes once destroyed or severely modified, cannot regenerate.

Leaving out the equally valuable but badly damaged coastal or aquatic ecosystems in Kerala, the highest priority was given to hill forest ecosystems and location-specific data was attempted to be collected for drawing up specific protection action plans.

This brief introductory report attempts to take stock of the remaining segments of tropical moist forests which possibly have long-term viability if protected. Details of how each particular tract can be protected and managed is elaborated in the subsequent reports.



SOUTHERN WESTERN GHATS
FOREST AREA - KERALA
ADMINISTRATIVE DIVISIONS
NATIONAL PARKS AND
WILDLIFE SANCTUARIES

SOUTH OF PALGHAT GAP [A]

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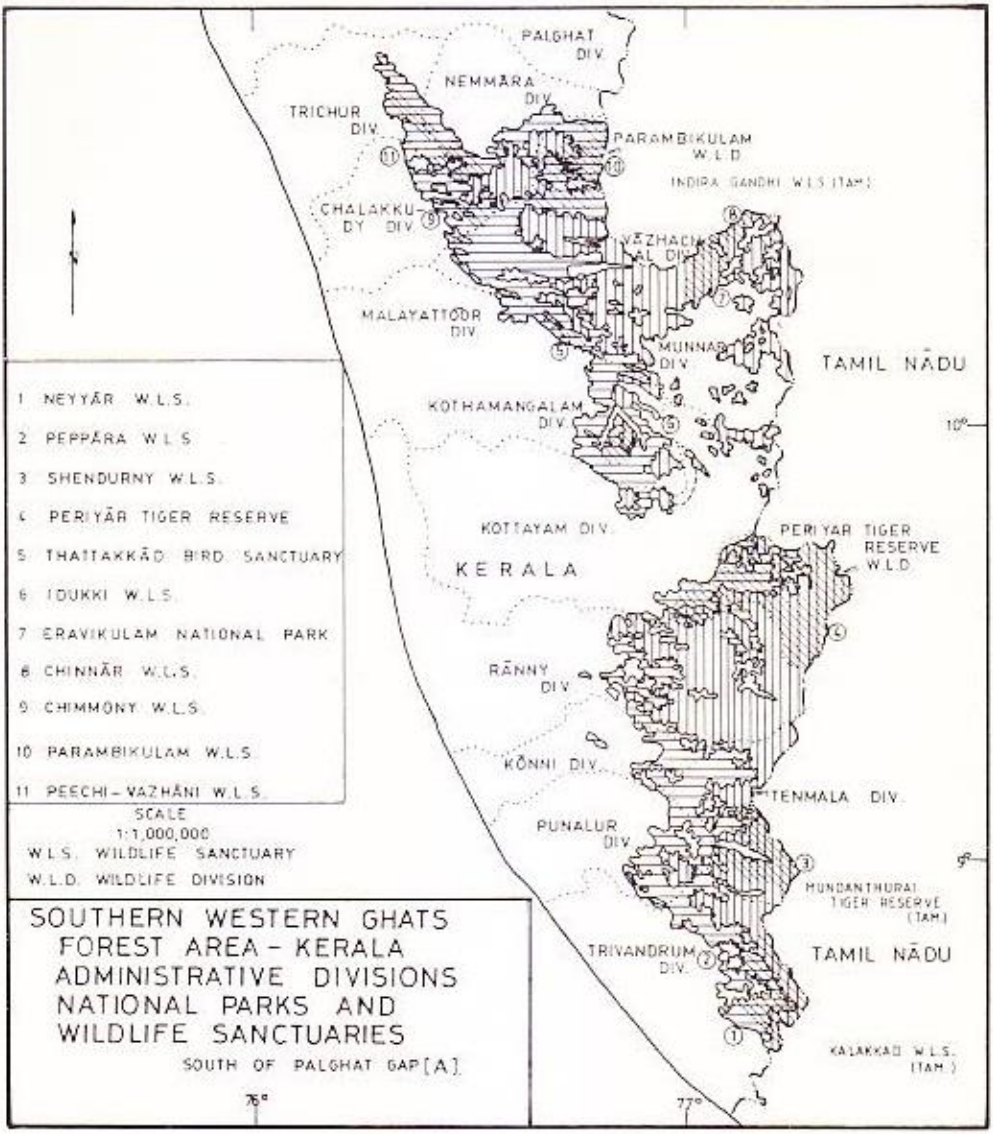
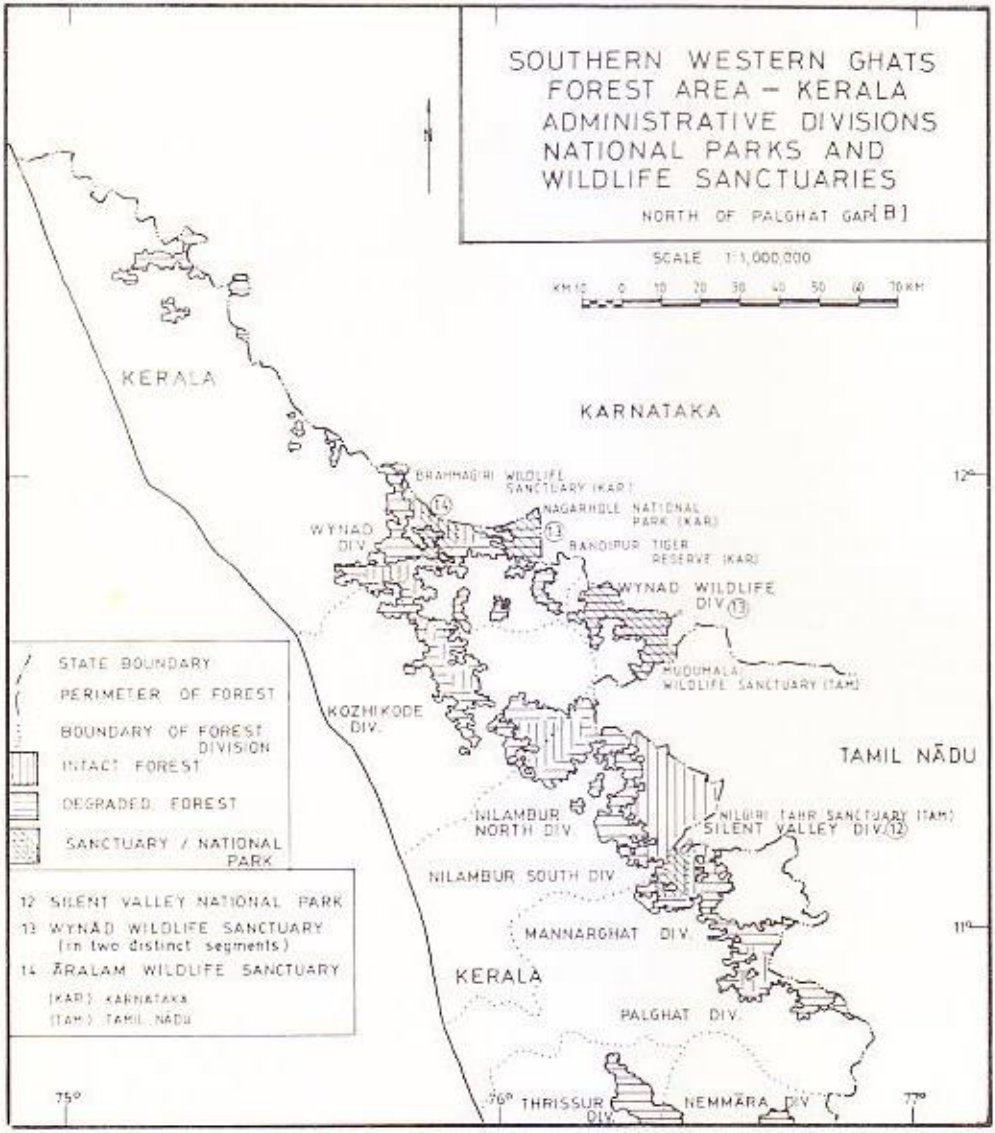


SOUTHERN WESTERN GHATS FOREST AREA - KERALA ADMINISTRATIVE DIVISIONS NATIONAL PARKS AND WILDLIFE SANCTUARIES

SOUTH OF PALGHAT GAP [A]


SOUTHERN WESTERN GHATS
FOREST AREA – KERALA
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NATIONAL PARKS AND
WILDLIFE SANCTUARIES
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TAMIL NĀDU
BRAHMAGIRI WILDLIFE SANCTUARY (KAR.)
NAGARHOLE NATIONAL PARK (KAR.)
BANDIPUR TIGER RESERVE (KAR.)
WYNAD DIV.
WYNAD WILDLIFE DIV. (13)
MUDUMALAI WILDLIFE SANCTUARY (TAM.)
KOZHIKODE DIV.
NILAMBUR NORTH DIV.
NILGIRI TAHR SANCTUARY (TAM.)
SILENT VALLEY DIV. (12)
NILAMBUR SOUTH DIV.
MANNARGHAT DIV.
PALGHAT DIV.
THRISSUR DIV.
NEMMARA DIV.
12°
11°
75°
76°
77°
STATE BOUNDARY
PERIMETER OF FOREST
BOUNDARY OF FOREST DIVISION
INTACT FOREST
DEGRADED FOREST
SANCTUARY / NATIONAL PARK
12 SILENT VALLEY NATIONAL PARK
13 WYNAD WILDLIFE SANCTUARY (in two distinct segments)
14 ĀRALAM WILDLIFE SANCTUARY
(KAR.) KARNATAKA
(TAM.) TAMIL NADU

CHAPTER THREE

An Overview of the Tract

The Western Ghats are the main peninsular hill range extending over 1400 km, starting in the north from near the Tapti River and ending in the south near Kanyakumari. They are almost parallel to the west coast and often hardly 40 km from it. Since the ghats extend along the coast rising up to an average elevation of 900–1500 metres above sea level, obstructing the monsoon winds from the south west, the orographic effect on the rainfall is considerable. The western slopes of the ghats receive very heavy rainfall ranging from 2000–6000 mm per year. But across the hill ranges eastward the rain decreases and the eastern slopes and foothills are almost rainshadow areas.

The Western Ghats are the main watershed in peninsular India from which all the principal rivers namely Godavari, Krishna and Cauveri originate and flow east emptying into the Bay of Bengal. A very large number of short, perennial, torrential west flowing rivers also originate from it and join the Arabian sea. The average height of the ghats is less than 1500 m above sea level. But in the southern reaches it rises upto 2000 m and to exceptionally higher peaks of 2500 m and above. Along its entire length this hill range has only one total discontinuity, the Palghat Gap in Kerala, where for more than 30 km there is a gap which has a floor height of less than 100 metres above sea level. This discontinuity is perhaps of tectonic origin through which a river could have flowed in ancient times.

The Western Ghats are essentially the western edge of the Indian peninsular plateau, which is a stable mass of Archaean and Pre-Cambrian formations, where the mountain building had ceased in the Pre-Cambrian times. The peninsular plateau is partly overlaid by the Gondwana and later formations and by the Deccan lava flows. The peninsular plateau is highest in the south and west and slopes eastward, the eastern edge forming the broken up Eastern Ghats. The Eastern and Western Ghats meet along the Moyar Gorge with the Biligirirangan Hills along the north-eastern side and the Nilgiris on the south west.

The Western Ghats show a few areas where the west flowing rivers have cut across the crestline and have captured drainage basins in the Deccan plateau. Immediately to the south of Goa, Kali, Gangavali, Bedti, Tadri and Sharavati have extended east into the Krishna and Tungabhadra drainage areas. As a consequence, the crestline of the watershed in the part of the Western Ghats east of Karwar recedes to more than 240 km east from the sea, instead of the usual 40 km or less.

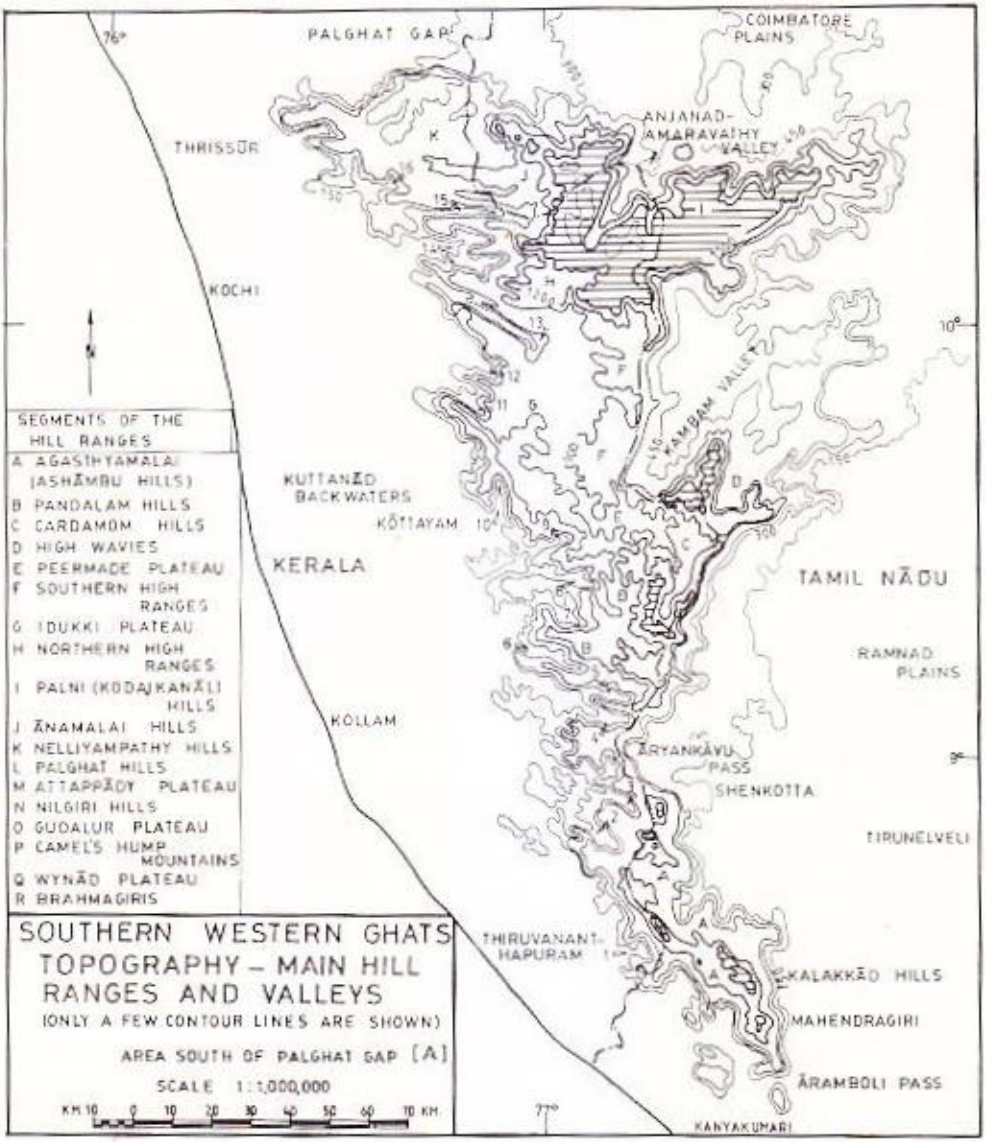
The Western Ghats presents an almost sheer, abrupt and straight face along its eastern edge to the south of the Palghat Gap up to the Shenkottah Gap. Near the Shenkottah Gap, the headwaters of Pamba and Achankoil rivers have, through headward erosion, pushed the watershed back to very near the eastern edge of the hills.

Structurally, the entire Western Ghats were part of the continental block of peninsular India, made up of metamorphic Archaean, i.e. Precambrian rocks (mainly gneisses, charnockites and schists). Until late Jurassic, it was part of the Gondwanaland along with South Africa, Madagascar, Antarctica and Australia. The Indian land mass collided with the Asiatic land mass thrusting up the Himalaya. There was tectonic strain in peninsular India also. The considerable strain that developed resulted in the horizontal and vertical dislocation of the parts of the precretaceous land mass in tertiary and quarternary periods. Most of the exposed gneisses of the Western Ghats are 2500 million years old and there are also intrusions with ages of about 2000–2110, 1000 and 450–600 million years.

A characteristic feature of the southernmost reaches of the Western Ghats (also in the geologically identical Central Mountains of Sri Lanka) are the high plateaux exemplified by the Nilgiris, Palnis, Anamalais and the High Ranges. These are not merely stumps of an eroded plateau but are also great horsts, uplifted during the post Jurassic times or even during the tertiary times. This is possibly simultaneous with the subsidence of the Arabian Sea from the Western Ghats. The fact, that the long straight edge of the Western Ghats in Maharashtra or Tamil Nadu developed on practically horizontal Deccan lavas and on ancient gneisses is supported by strong evidence of faulting and subsidence on a large scale. The uplifted horsts, from the morphodynamic point of view shows geomorphologically a mixture of 'mature' as well as 'juvenile' relief types. The extensive, almost level surface and plateau are examples of the mature land form while the steep mountains and escarpments dissected by erosion are characteristic of juvenile land forms.

From the administrative and development planning perspective, the Western Ghat tract is one of the most important and at the same time problematic areas in peninsular India. It is rich in natural resources like water, forests, etc. At the same time there are serious handicaps such as ecological vulnerability, communication bottlenecks, scattered nature of settlements, etc. curtailing options in development.

Identified as a special development region, the Western Ghats comprise 134 talukas in the states of Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala covering an


76°
PALGHAT GAP
COIMBATORE PLAINS
ANJANAD-AMARAVATHY VALLEY
THRISSUR
KOCHI
10°
KAMBAM VALLEY
KUTTANAD BACKWATERS
KOTTAYAM
KERALA
TAMIL NADU
RAMNAD PLAINS
KOLLAM
ARYANKAVU PASS
SHENKOTTA
TIRUNELVELI
THIRUVANANTHAPURAM
KALAKKAD HILLS
MAHENDRAGIRI
ARAMBOLI PASS
77°
KANYAKUMARI
SEGMENTS OF THE HILL RANGES
A AGASTHYAMALAI (ASHAMBU HILLS)
B PANDALAM HILLS
C CARDAMOM HILLS
D HIGH WAVIES
E PEERMADE PLATEAU
F SOUTHERN HIGH RANGES
G IDUKKI PLATEAU
H NORTHERN HIGH RANGES
I PALNI (KODAIKANAL) HILLS
J ANAMALAI HILLS
K NELLIYAMPATHY HILLS
L PALGHAT HILLS
M ATTAPPADY PLATEAU
N NILGIRI HILLS
O GUDALUR PLATEAU
P CAMEL'S HUMP MOUNTAINS
Q WYNAD PLATEAU
R BRAHMAGIRIS
SOUTHERN WESTERN GHATS
TOPOGRAPHY – MAIN HILL RANGES AND VALLEYS
(ONLY A FEW CONTOUR LINES ARE SHOWN)
AREA SOUTH OF PALGHAT GAP [A]
SCALE 1:1,000,000
KM 10 0 10 20 30 40 50 60 70 KM

area of about 0.14 million sq. km with a population of 32.7 million in 1981. Scheduled caste and scheduled tribe account for nine and 4.7 percent of the population respectively for the whole region. There are about 14,000 human settlements in this tract.

3.1 Subregions of the Western Ghats

Although the Western Ghats extends over 1400 km along the states of Maharashtra, Goa, Karnataka and Tamil Nadu, geographically it is divided into three distinct subregions.

The northernmost is the Maharashtra Sahyadris, extending from the Tapti River to south of Goa, rising up to an elevation of 900 m-1200 m above sea level. It is composed of Deccan lavas descending steeply to the undulating narrow Konkan coast. It has a much dissected western face cut up by canyon-like valleys into mesas, buttes and pinnacles. To the east of the crest, there are broad, mature or senile valleys on the plateau.

From near the southern parts of Goa, the current Western Ghats extend about 320 km south to Coorg. It is composed of old gneisses and granite and the crestline has been eroded down to less than 900 m. above sea level. The watershed crestline has been pushed deeply back east into the Deccan plateau and the features of the ghats are not abrupt.

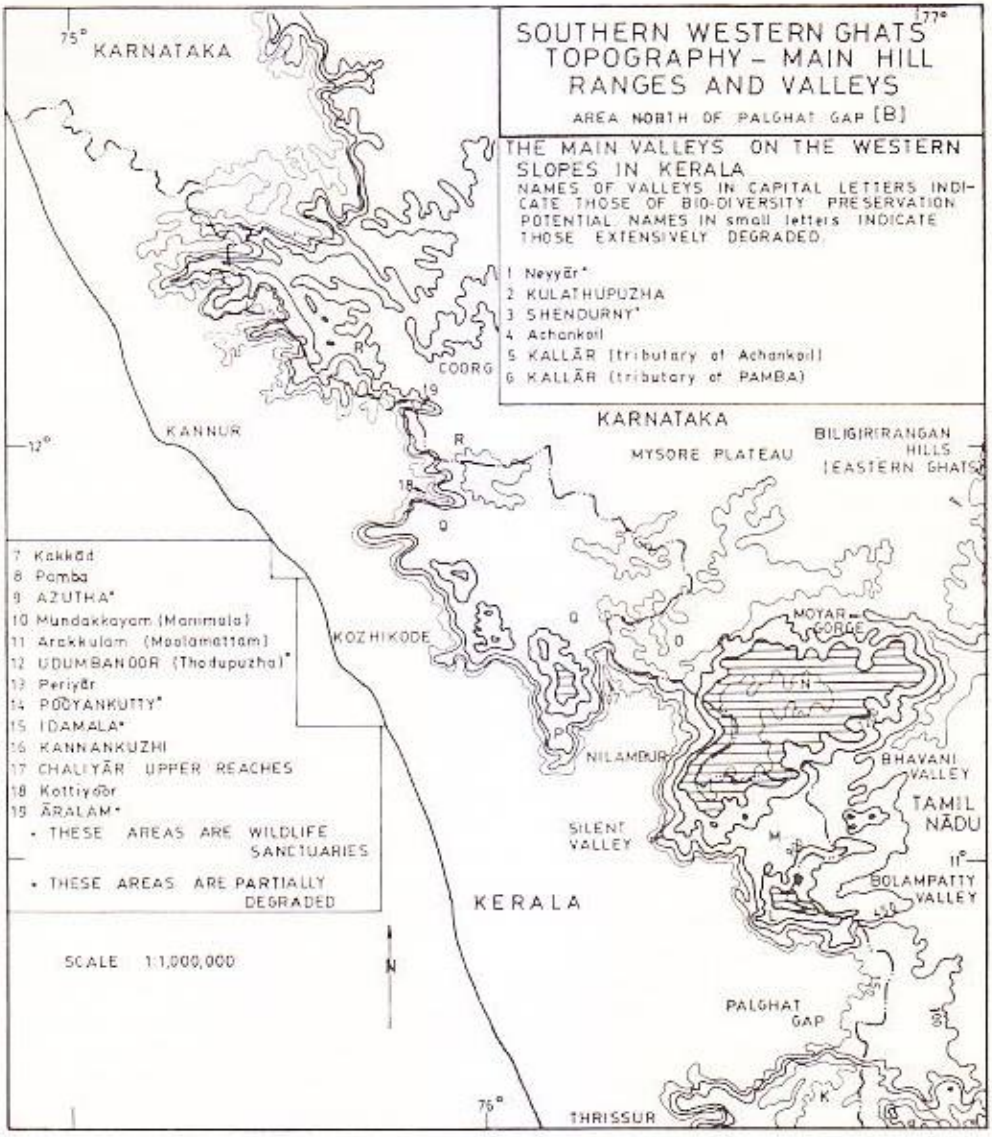
South from south Canara where the wide Netravati Valley forms an almost 75 km wide embayment into the ghats, the southern Western Ghats starts. It rises abruptly to gneissic bosses such as the Nilgiris. South of the Palghat Gap, the mountains continue unbroken to very near the southern tip of the peninsula to the Mahendragiri peak.

3.2 Climate

The Western Ghat tract is a monsoonal area. The word monsoon, meaning 'season', denotes the phenomenon of a large scale, annually recurrent, seasonal change of wind, which blows consistently from opposite directions in two different seasons. The alternation of north-easterly surface winds during the northern hemispheric winter and south-westerly winds during summer are referred to as the north east and south west monsoons.

Taking into account the wind and weather conditions over southern India, the seasons over the Western Ghats can be distinguished as the north-east monsoon period extending from December to March, followed by the first intermonsoon during April-May, the south-west monsoon period commencing from June and lasting till September, to be followed by the second intermonsoon during October-November.

A characteristic of all mountains areas is the nonuniformity of ground conditions. Climate is one such wide ranging variable. Interlinkages between topography, climate and ecosystems makes it a confusing variety of constantly changing situations. The


SOUTHERN WESTERN GHATS
TOPOGRAPHY – MAIN HILL RANGES AND VALLEYS
AREA NORTH OF PALGHAT GAP (B)
THE MAIN VALLEYS ON THE WESTERN SLOPES IN KERALA
NAMES OF VALLEYS IN CAPITAL LETTERS INDICATE THOSE OF BIO-DIVERSITY PRESERVATION POTENTIAL. NAMES IN small letters INDICATE THOSE EXTENSIVELY DEGRADED.
1 Nevyār *
2 KULATHUPUZHA
3 SHENDURNY *
4 Achankoil
5 KALLĀR (tributary of Achankoil)
6 KALLĀR (tributary of PAMBA)
7 Kakkād
8 Pamba
9 AZUTHA *
10 Mundakkayam (Manimala)
11 Arakkulam (Meelamattam)
12 UDUMBANOOR (Thodupuzha) *
13 Periyār
14 POOYANKUTTY *
15 IDAMALA *
16 KANNANKUZHI
17 CHALIYĀR UPPER REACHES
18 Kottiyoor
19 ĀRALAM *
* THESE AREAS ARE WILDLIFE SANCTUARIES
• THESE AREAS ARE PARTIALLY DEGRADED
SCALE 1:1,000,000
N
KARNATAKA
KANNUR
KOZHIKODE
COORG
KARNATAKA
MYSORE PLATEAU
BILIGIRIRANGAN HILLS (EASTERN GHATS)
MOYAR GORGE
NILAMBUR
BHAVANI VALLEY
TAMIL NĀDU
SILENT VALLEY
BOLAMPATTY VALLEY
KERALA
PALGHAT GAP
THRISSUR
75°
77°
12°
11°

Western Ghats are no exception, presenting a whole range of gradients, both altitudinal as well as latitudinal in many climatic factors, such as total annual rainfall, peak rainy season and its duration, number of rainy days, maximum and minimum temperatures and the season of the year when it is experienced, wind velocity, direction, etc. To give a few examples, the southern Western Ghats show an increase in total annual rainfall from south to north, but the spread of the rainy season decreases. In a west to east transect, from the coast to the western face of the ghats, there is a sharp increase in the total precipitation. Then it decreases across the ghats sharply towards east and again slowly picks up towards the eastern coastal stretch. The peak rainy season is June to August along the western face of the Ghats while it is October to December along the eastern edge of the ghats. The aspect of individual valleys, the presence of sheltering high ridges especially on the windward side, etc. influence the local climate substantially. Hence there is unexpected and drastic local variation in climate within the tract.

The importance of wind direction and velocity, for example, could control the moisture and temperature regimes of a region, and hence decide the nature of biotic communities. Even less significant and unmonitored aspects such as intensity of rainfall, droplet size, total incident solar radiation, albido, etc. exert important influences in the direction of ecosystem changes. For protection, management or for restoration of ecosystems and biotic processes, an understanding of the local climate is essential.

3.3 Soils

The area of study is vast and heterogeneous, with marked horizontal and vertical diversity of edaphic and biotic conditions. In any case, there is a surprising paucity of data on the soils of the Western Ghats. In general it may be mentioned that three general types of forest soils are met with here:

(a) The alluvial soils : Slope and fluvial processes build up humus and rich deep deposits of alluvium in suitable locations such as river valleys and plateaux.

(b) The red soils : Developed best on archaean cryastalline rocks. This soil type which is common in the southern Western Ghats may be brown, grey or black depending on the parent rock, climate, local terrainal conditions, etc. even though it is called red soil.

(c) Lateritic soil : The commonest soil along the lower elevations in the southern Western Ghats. It is formed by exposure to oxidation, leaching and physical weathering of soils which have high concentrations of the oxides of iron, aluminium, titanium and manganese; which at the same time suffer the near total loss of lighter elements, organic content and silica.

3.4 The study area : some specific locations

The study is restricted to the southern Western Ghats in Kerala extending from 8°30'N

to 12°30'N latitude and 75°15'E to 77°45'E longitude. Along most of its length the inter-state border parallels the main watershed between the west and east flowing rivers starting from the Western Ghats, and it is mostly close to the eastern edge of the ghats. Most of the hill areas in Kerala fall on the western side with few exceptions. The area in Tamil Nadu is mostly the eastern scarps and the spurhills, extending towards the north east.

Tropical moist forest areas of potential conservation value in Kerala are scattered over more than 20,000 sq.km. Natural topographic features such as mountain ridges and valleys divide it into a number of sub-units. They are the following :

3.4.1 *The Agasthyamalai Range*

The southernmost reaches of the Western Ghats, i.e. the Agasthyamalai Range extends from Mahendragiri near Kanyakumari in the extreme south to the Ariyankavu Pass near Shenkottai. Beyond the Mahendragiri, further south, the Aramboli pass in the Kanyakumari-Thirunelveli district border actually forms the southern extremity of the Western Ghats. Still south there are only scattered, mostly rocky, steep hills extending almost to the tip of the peninsula. This is a compact range of hills with a main range descending equally steeply to both the western and eastern sides. The northeastern corner of this range has a significant area of forests on the eastern slopes, forming the catchment area of the Thambraparni river. There are extensive forests on the northwestern side also. The northern limit of this range, i.e. the Aryankavu pass is not very clearly demarcated. There are short hill ranges or isolated hillocks scattered along the valleys of Kallada and Achankoil rivers in their upper reaches, constituting the Aryankavu pass. The Agasthyamalai Range continues into Tamil Nadu, south of the Kerala border. This is the only part of the Western Ghats where some stretch of the western slopes are also in Tamil Nadu. Some of the best tropical moist forests in the Western Ghats are in this stretch.

3.4.2 *The Pandalam Hills*

The section of the southern Western Ghats south of Peermade-Kumily-Kambam axis extending south up to the Achankoil valley, is a very rugged stretch of mountains known as the Pandalam Hills. It is one of the exceptional areas in the southern Western Ghats, in that there are two parallel, equally high, north-south watershed lines within the same section of the ghats, separating two west flowing rivers. The northeastern parts of the Pandalam Hills are drained by the Periyar River and the northwestern parts by the Pamba river. In the southern half of the Pandalam Hills, the headward erosion of the tributaries of Pamba and Achankoil rivers have pushed the watershed line to very near the eastern edge of the Western Ghats. The western front of the Pandalam Hills descends gradually, through a wide zone of foothills, to

the plains of Kottayam, Pathanamthitta and Quilon districts. The eastern edge of this section of the Western Ghats is an almost straight line sheer scarp.

3.4.3 *The Cardamon Hills*

North of the Pandalam Hills, extending north for almost 80 km up to the edge of the High Ranges (the Kannan Devan Hills), is an extensive plateau, the Caradamon Hills, at an average elevation of 900 metres above sea level. The eastern edge of this plateau, as in the case of Pandalam Hills, is a straight line scarp face falling off to the Tamil Nadu plains. The entire area is drained by Periyar. The western parts, west of the main channel of Periyar, is of slightly different topography. This region—the Idukky area—descends rather abruptly to the plains of Kottayam district. These western slopes are drained by Manimala, Meenachil and Moovattupuzha rivers.

Extending north east from Kumily, at the eastern junction of Cardamom Hills and Pandalam Hills, there is a steep and high spurhill projecting into the Tamil Nadu plains. This is the High Wavies or the Varushanad Hills, which terminate in the Andipatti Hills. Excepting its southwestern junction with the main Western Ghats, the High Wavies are entirely in Tamil Nadu.

3.4.4 *The High Ranges*

The widest reach of the Western Ghats in Kerala is the High Ranges. It is also the highest reach. The High Range part is divided into three sub regions—the central High Ranges proper, (more appropriately called the Kannan Devan Hills), the eastern Anjanad Valley and the western Pooyankutty-Idamala Valleys. The Kannan Devan Hills are drained by Muthirapuzha. The Anjanad Valley, which is located in between the Anamalais, the Kannan Devan Hills and the Palnis, is drained by the tributaries of the east flowing Amaravathy river. The western slopes of the central High Ranges have been deeply carved out into a complex of valleys by the northern tributaries of Periyar—the Idamala and Pooyankutty rivers which have created an extensive drainage basin heavily clothed in tropical moist forests.

To the east of the central High Ranges and to the south east of the Anjanad Valley, there is a spurhill range of the Western Ghats extending north east into Tamil Nadu. This ridge with an extensive high elevation plateau is the Palni Hills or the Kodaikanals. Only the extreme southwestern face of this range, in the eastern slopes of the Vattavada Valley is in Kerala.

3.4.5 *The Nelliampathies and the Anamalais*

South of the Palghat Gap, the Western Ghats widen out with extensive ridges and undulating reaches. The Nelliampathy Hills form the southern and southwestern

margin of the Palghat Gap and they extend south, enclosing the Parambikulam basin. The western edge of the Nelliampathies gradually descend to the midlands of Trichur district through a wide foothill zone drained by Puzhackal and Karuvannur rivers. The north-western corner of Nelliampathies extend far north-west almost up to Bharathapuzha as a spurhill, the Pattikad-Vadakkancherry-Vazhani Hills. The Parambikulam basin drains towards south and west through the Chalakkudy River. The eastern border of Parambikulam basin so formed by the Anamalais, a high ridge which starts from near the south-eastern corner of the Palghat Gap and sweeps south and south-east meeting with the High Range near Anamudi. South, in between the southern Idamala-Poonyankutty valleys and the southern edge of the Parambikulam basin, there is the east-west Chalakkudy Valley, the upper reaches of which are formed by Sholayar, a tributary of the Chalakkudy river and the lower reaches by the main Chalakkudy river. Part of the Anamalais, upper reaches of Sholayar and the eastern parts of the Parambikulam basin are in Tamil Nadu. This extensive, slightly lower basin, sheltered by the Nelliampathies in the north, Anamalais in the east and the Kannan Devan Hills in the south draining through the Periyar as well as the Chalakkudy rivers had, till recently, one of the most extensive tropical moist forests in the entire Western Ghats.

3.4.6 *The Palghat Hills*

The northern tip of the Palghat Gap rises abruptly from near the Walayar-Madukkara area, as a narrow steep ridge which runs west and curves north along a series of ridges known as the Palamala-Elival-Muthikulam Hills, and then continues north along the Attappady plateau up to the base of the Nilgiris. These hills, in general, are called the Palghat Hills. They include a series of high, steep, almost east-west ridges with fairly undisturbed high elevation tropical moist forests called the Palamala-Elival Hills. This continues to a compact high plateau called the Siruvani (Muthikulam) Hills which in turn continues east and north-east along the eastern edge of Attappady, the Varadimala-Bolampatti Hills and the outer rim of hills along the Attappady western edge.

Attappady is an extensive east sloping, gently undulating plateau, sandwiched in between the Nilgiris to its north and the Palghat Hills to its south, east and west. Once it was heavily forested but at present practically totally barren. The eastern outer slopes of the Palghat Hills are in Tamil Nadu.

The eastern ridge into Tamil Nadu encloses the Bolampatti Valley drained by the Noyil river. The southern and western faces of the Palghat Hills are drained by the tributaries of the Bharathapuzha, and the Siruvani and the Attappadi plateaux by the east flowing Bhavani and its tributaries.

3.4.7 *The Nilgiris*

The most extensive eastern spurhill of the Western Ghats, the Nilgiris, is a high steep plateau, rising from the edge of the Mysore plateau in the north and extending south up to Bhavani with its eastern end approaching the Biligirirangans, a part of the Eastern Ghats, north of Moyar. The southern edge of the Nilgiris along the Attappady plateau rises up into the Kunda Hills. The Silent Valley and Attappady forests are on the south-west corner and extensive forests draining into Chaliyar cover most of the western slopes. The Nilgiri mountains are mostly in Tamil Nadu and only the south-western and western slopes are in Kerala.

3.4.8 *Wynad*

Along its north-west corner the Nilgiris descend to a mid level plateau, the Gudalur-Cherambadi tract which continues into the extensive Wynad part. Wynad, like Attappady, is an east sloping, gently undulating, medium elevation plateau abruptly descending in the west to Kerala plains but merging imperceptibly with the Mysore plateau to the east. Kabini and Moyar rivers drain the Wynad-Gudalur tract into Tamil Nadu. Again like Attappady, this tract was also extensively forested till fairly recently. But extensive forest working, conversion of forests to teak and eucalyptus tree plantations, tea, coffee, pepper cash crop plantations, and outright clearance of forests for settlements have destroyed most of the forests of Wynad, except along the eastern edge in Tamil Nadu and Karnataka and along the western outer slopes in Kerala.

Along the south-western corner of Wynad, there is a knot of isolated high ridges. This is the Camel's Hump Mountains, distinct from Wynad but closely similar to the Nilgiris in ecological conditions. This is biogeographically a valuable area with a significant extent of tropical moist forest.

3.4.9 *The Brahmagiris*

The north-eastern corner of Wynad rises up to a hill range called the Brahmagiris. This forms the western and south-western border of the Coorg plateau. It descends extremely steeply to the plains of Kerala to the west, drained by a number of small rivers. Only a part of the Brahmagiri western slopes drained by the Aralampuzha falls in Kerala. This range of hills continues north to the Netravathy watershed and is the northern limit of the southern Western Ghats.

CHAPTER FOUR

Biological Diversity of the Western Ghats

4.1 The biological heritage of India

The Indian sub-continent has one of the richest biotas in the world. There are at least 13,000 species of flowering plants, including more than 2500 species of trees. The diversity of lower forms of plants is equally rich. There are 340 species of mammals, 1200 species of birds, 420 species of reptiles, 40 species of amphibians, 2000 species of fishes, 4000 species of molluscs, 50,000 species of insects and about 6500 species of other invertebrates. There are approximately 21,000 species of higher plants and 65,000 species of animals. This is 5.2 percent of all known plants, and 4.3 percent of all known animals in the world.

This great diversity of plants and animals is due to the vast geographical area extending over many degrees of latitude, varied topography, climatic zones, and the position of the country at the junction of so many biogeographic regions and sub-regions. Biotas from Malaysia, humid as well as arid zones of Africa and Europe, and temperate regions of Asia, Mediterranean lands, West Asian deserts, and the subtropical reaches of China have intermingled with many endemic forms to produce this exceptional richness.

Yet perhaps, no other region of comparable size in the world has suffered so much human interference and consequent impoverishment of biota as the Indian subcontinent. Climax vegetation over most of the plains, river valleys, coastal stretches and all accessible reaches in mountain slopes have been destroyed and replaced with crops, or by grasslands, scrub, savannahs and such other biotic or bioedaphic communities which may be post-climax, pre-climax or sub-climax stages.

The greatest concentration of the remaining climax vegetation or biological diversity is in the eastern Himalayas, the inaccessible reaches of the western Himalayas, the Western Ghats and the Andaman and Nicobar islands.

4.2 Biological wealth of Western Ghats

In peninsular India where maximum anthropogenic modification of ecosystem have taken place, the only remaining islands of relatively undisturbed natural ecosystems are in the Western Ghats. A considerable part of the residual endemic flora and fauna of the peninsular is also concentrated here. The complex topography, high rainfall, relative inaccessibility of the tract and biogeographic isolation, have helped the Western Ghats retain their biological diversity to some extent—at least until very recently.

Although the flora and fauna of this peninsular hill range show a prominent affinity to the Assam, Malayan and Indo-Chinese biota, there is also at present a very wide variety of exotic naturalised species which were mostly introduced since the advent of European colonisers. There are a large number of tropical American and Australian elements. Some peculiarities of the flora and fauna of this region is the presence of a large number of Pleistocene relicts which are temperate, and boreal species of the Himalaya, that once had a continuous range but which later became isolated in the post-glacial climatic and consequent ecological changes. The many hill tops and plateaux reaching 2000 metres or more in elevation harbour relict vegetation of sub-temperate zones.

Delimited by the sea to the west, the Vindhya and Satpura ranges to the north and the arid Deccan plateau to the east, the Western Ghats are insulated and isolated. Hence the high percentage of endemism. The very humid climate with an average dry season of four to five months (which is reduced to less than two months in the extreme southern sections of the ghats) result in many groups of plants and animals showing rich species diversity. Chatterjee (1940) who compared the floristic endemism in India has estimated that the Himalayas has 3169 species of endemic dicots and peninsular India about 2045, out of which 1500 species are from Western Ghats. There are about 280 arborescent endemics in the Western Ghats from the south of Karnataka and 70 species are restricted to the southernmost Travancore region.

4.2.1 *Floristic wealth*

Floristically, the Western Ghats is one of the richest areas in the country, harbouring no less than 3500 species of flowering plants which is 27 percent of flowering plants in the country. There is an equal, if not richer, proportion of lower plants.

The ten dominant natural orders of plants in the Western Ghats are : Gramineae, Leguminosae, Acanthaceae, Orchidaceae, Compositae, Euphorbiaceae, Rubiaceae, Asclepiadaceae, Geraniaceae and Labiatae.

The genera found in the region with more than 15 species each are : *Crotaleria, Impatiens, Diospyros, Ipomoea, Eugenia, Strobilanthus, Ficus, Desmodium, Habenaria, Grewia* and *Osbechia.*

There are 58 endemic genera mostly confined to the Western Ghats, of which 47 are monotypic. Gramineae (Poaceae) has the highest number of endemic genera and

the genus *Nilgirianthus* has the maximum number (20) of endemic species. Tree genera endemic to the Western Ghats are : *Blepharistemma*, *Erinocarpus*, *Meteromyrtus*, *Otonephelium*, *Poeciloneuron* and *Pseudoglochidion*. Other endemic genera of Western Ghats are : *Adenoon*, *Griffithella*, *Willisia*, *Meineckia*, *Baeolepis*, *Nanothamnus*, *Wagatea*, *Campbellia* and *Calacanthus*.

There are six genera and 17 species belonging to Bambusae in the Western Ghats. Out of the eight species in the genus *Ochalandra* belonging to Bambusae reported from India, six are from the Western Ghats. In the herbaceous plant genus *Impatiens*, out of the 175 species reported from India, 77 species are from the southern Western Ghats. The stretch of the ghats, south of Coorg is the richest region. Out of 21 palms reported from the Western Ghats, *Bentenckia coddapanna*, *Pinanga dicksonii* and nine species of *Calamus* are endemic to this section. There are four species of *Myristica: M. malabarica* (which is endemic), *M. fragrans* (which is the cultivated nutmeg tree), *M. dactyloides* and *M. falma* var. *magnifica* reported from here. Podostemaceae, Umbelliferae, Loranthaceae and Acanthaceae are very well represented in the southern Western Ghats. The wild relatives of many economically important plants like *Dioscorea*, *Elettaria*, *Musa*, *Oryza*, *Piper*, *Zingiber* and *Curcuma* are also abundant here.

The Western Ghats is the most important distribution range for many plant families and genera. In the leguminous genus *Dalbergia* is of economic importance (since the very valuable rosewood is from this genus). There are about 100 species reported from all over the world, of which 25 species are from India. Of this, 22 species and one variety are from the Western Ghats. Within the Western Ghats, the Kerala area has the richest assemblage, with 17 species and one variety. Two species, namely, *Dalbergia beddomei* and *D. travancorica* are endemic to the ghats of the state. The former occurs only in the Silent Valley and the latter in the Agasthyamalai Range (K.K.N. Nair, 1984).

The Western Ghats has 84 species and two varieties of endemic orchids belonging to 30 genera (three genera are endemic). Of the known orchids of Indian Peninsula, 37 percent are endemic to the Western Ghats region—58 species are known from Kerala of which 15 species are restricted to this state. Six species of orchids occurring in Kerala have been collected only once and could very well be extinct. Fifteen species of orchids are endangered in the Western Ghats, of which three are exclusively found in Kerala and three along the Kerala-Tamil Nadu border (Satish Kumar, 1984).

Many plants found in the Western Ghats are of extremely restricted distribution. For example, *Proteroceras holttumii* is a small epiphytic orchid (the genus is endemic to the Western Ghats) and it is found only on the eastern slopes of Vellingiri Hill located in the Kerala-Tamil Nadu border. Similarly *Haplothismia* is a new monotypic genus reported from Parambikulam area: from a location which has since been submerged under a reservoir. It has not been relocated.

Extremely restricted areas have been reported as the type localities for a number

of species of plants, many of which are endagered or rare. For example, the Chemmunji Peak area in the Agasthyamalai Range is the type locality for half a dozen endemic species. (Henry, A.N., K. Vivekananthan, N.C. Nair, 1979). Agasthyar Peak itself is floristically an exceptionally rich area, with a number of species of restricted distribution.

Silent Valley Reserved Forest—in particular the Sispara pass along the Silent Valley-Nilgiri border—is perhaps one of the richest locations in the entire Western Ghats for the number of plants occurring there and nowhere else.

4.2.2 *Fauna*

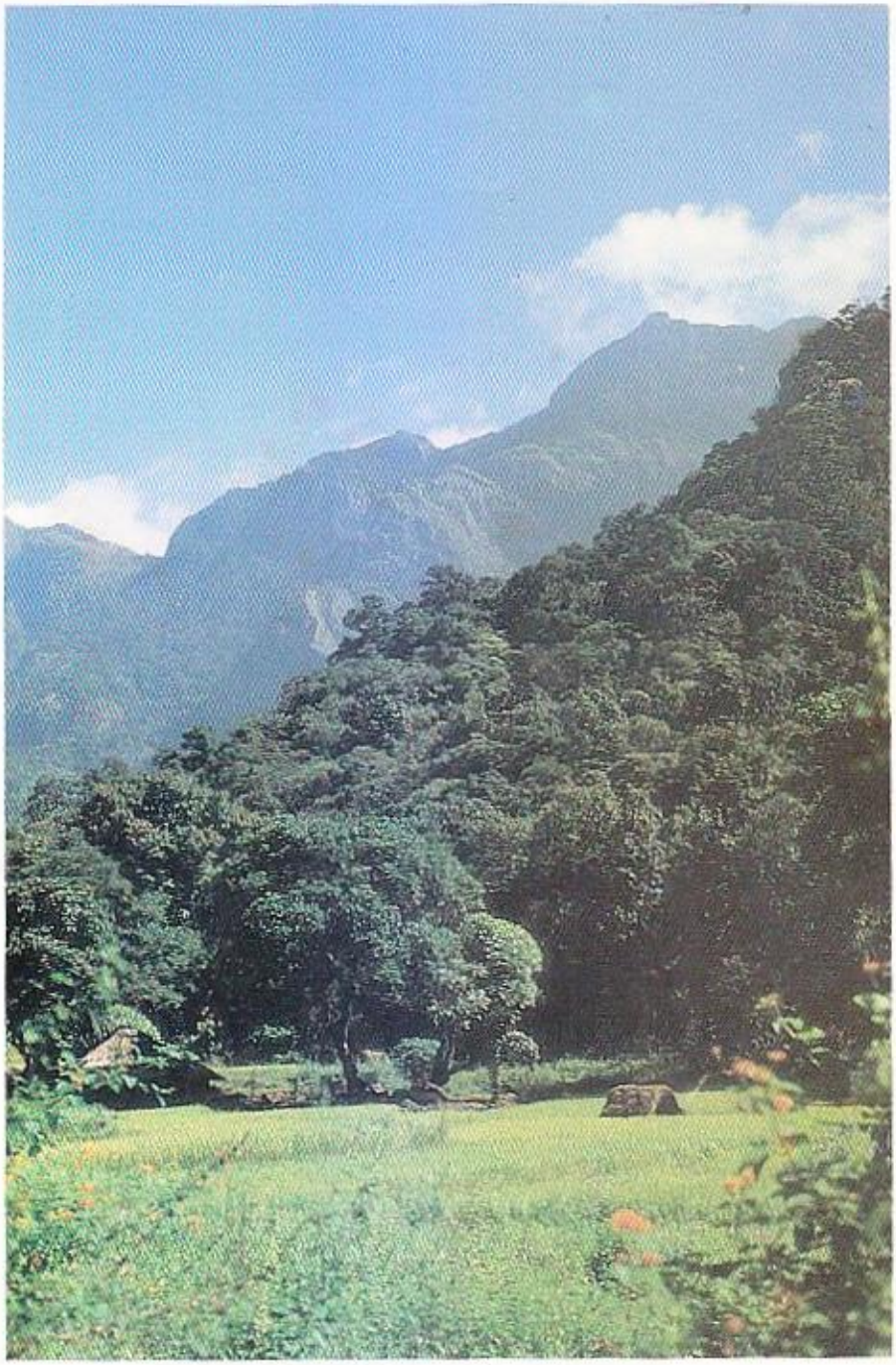
Diversity as well as endemism is equally obvious among animals in the Western Ghats, as among plants. Blanford lists 48 genera of mammals, 275 genera of birds (with 28 endemic forms), 60 genera of reptiles with seven *Hoplodactylus, Salea, Pseudoplecturus, Pleucturus, Melanophidium, Platyplecturus* and *Xylophis* endemic forms in the Western Ghats from river Tapti to Cape Comorin.

The amphibian genera, *Nyctibatrachus, Nannobatrachus, Melanobatrachus, Nectophryne* and *Geganophis* are restricted to the southernmost part of the Western Ghats. Of this 41.6 percent are endemic. Of the known five genera and 13 species of Gymnophiona, all except one species is restricted to the southern Western Ghats. This is out of a total of 17 genera and 75 species in the world. The order Salientia is the best represented amphibian group in India. The genus *Rana* within this order with 35 species reported from India, is mainly found in the peninsula, with 14 species endemic to the Western Ghats. Family Rhacophoridae with two genera and nine species from India has four endemics in the Western Ghats. In the genus *Rhacophorus*, and in the other genus. *Philautus*, there are eight endemic species occurring in the Western Ghats, out of the 10 species known from India. Family Bufonidae has three genera. The genus *Nectophryne* has the endemic *N. tuberculosa* in the Western Ghats. In the genus *Bufo*, out of 15 species 7 are endemic to Western Ghats and the third genus, the monotypic *Ansonia* is found only in the Mysore part of the Ghats.

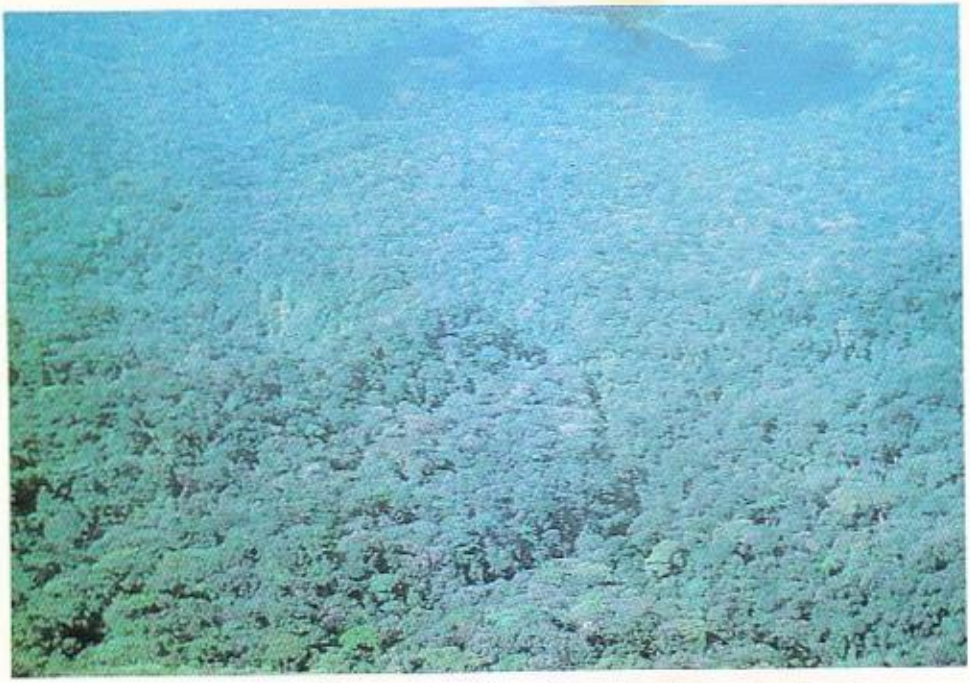
A total of 683 species of primary fresh water fishes belonging to 89 genera and 17 families have been reported from Indian territory. Of this 58 genera are oriental Indian, wherein a significant percentage is endemic to the Western Ghats. *Lepidopygopsis, Batasio, Travancoria* are examples of genera restricted exclusively to the hills south of the Palghat gap.

The distribution of many of the invertebrate groups also show a very similar distribution, with a high concentration in the Western Ghats, in particular to its southern reaches. The Oligochaete annelids provide an illustrative example.

The endemic forms of large mammals in the Western Ghats are better known than the lower groups. The rusty spotted cat (*Felis rubiginosa*), Malabar civet (*Viverra*

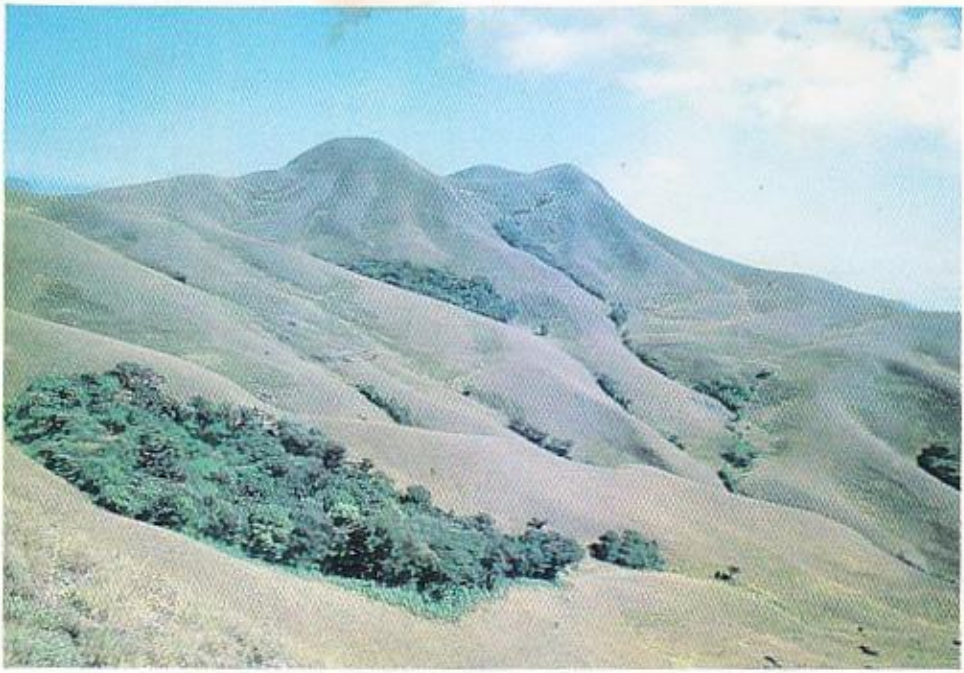


A typical view of the densely wooded steep slopes rising abruptly from the valleys



An unbroken stretch of the evergreen forest. Most of such stretches have been fragmented, degraded or totally destroyed. (Anaimudy Reserved Forest)

The wet evergreen forests of the southern Western Ghats at an elevation of 900 m. (Silent Valley National Park)



The high elevation shola-grassland ecosystem. The stunted evergreen forests (sholas) are restricted to hill folds surrounded by extensive grassy downs. (Eravikulam National Park, above 2000 m)

The treeless grassy crest-line areas where winter frost, desiccating wind and annual fires suppress regeneration of forest. (Eravikulam National Park)

Evergreen forests along the accessible reaches degrade to moist deciduous forests through gradual human interference. (Nagarampara Reseryed Forest)

Introduction of cash crop plantations since early 19th century fragmented the original forest cover. (Kalakkad Hills)

megaspila—believed to be extinct), the brown palm civet (*Paradoxurus jerdoni*), the stripe necked mongoose (*Herpestes vitticollis*), the brown mongoose (*Herpestes macroura*), the Nilgiri marten (*Martes gwatkinsi*), the grizzled giant squirrel (*Ratufa macroura*), the Nilgiri tahr (*Hemitragus hylocrius*), the lion-tailed macaque (*Macaca silenus*), the Nilgiri langur (*Presbytis johnii*) are some of the large mammals restricted to the southern Western Ghats. There are also a number of smaller rodents and Chiropterans restricted to this area.

CHAPTER FIVE

The Biogeographic basis for a Conservation Action Plan

A scientifically sound strategy for the conservation of the entire biological diversity of the country requires detailed and accurate ground information on the distribution of all plants and animals. Such exhaustive information is not available for our country. An indirect means to preserve as much of the biological diversity as feasible is through protecting representative and viable units of the entire spectrum of ecosystems, available within the biogeographical region/sub-regions.

For preparing such a blueprint for conservation of biota, one of the essential steps is to catalogue all identifiable ecosystems occurring within the particular region. One way of doing it for the terrestrial habitats is by identifying all distinct vegetation types in the region. The plant communities being primary producers reflect the basic characteristics of the physical environment, and also in turn decide the identity of the consumers—the animals.

There had been many earlier attempts to identify the distinct biogeographic sub-regions of the country on the basis of the distribution of a variety of plants and animals. But none of these attempts have been wholly satisfactory. The Western Ghats more or less correspond with the 'Malabar' region identified by many plant and animal geographers. Biogeographically, the Western Ghats fall within the 'oriental biogeographic region' (Code No. 5) which encompasses the entire subcontinent and it corresponds with the biotic province of 'Malabar Rainforest' (Code No. 5.7.7.) in the international system for defining and classifying natural areas for purposes of conservation evolved by the IUCN (Dasmann, 1973).

5.1 Ecosystem conservation

If all the ecosystems in the region are known, it is possible to identify intact representative areas from each ecosystem for long-term preservation. This in turn will guarantee the preservation of as wide a spectrum of biota as possible. This approach would

require scientific data such as:

(a) an exhaustive catalogue of types of ecosystems and the range of distribution of the different ecosystems; and

(b) the minimum area required to protect a viable unit of ecosystem.

None of this information is as yet available. This approach has the potential danger that, with such a complex topography and variation in edaphic factors between sites, variation in plant and animal communities would be too high to be adequately covered by locating sample areas in ecosystems. The existing biogeographic information on the southern Western Ghats shows such a high degree of endemism and number of species with extremely restricted distribution, that the fear of inadequate coverage seems justified.

5.2 Species conservation

Attempts could be made to protect the habitats of as many species of plants and animals as possible. But then, the difficulties are that:

(a) We do not have exhaustive information on the distribution. Taxonomic surveys are inadequate in this part of the country for all groups of plants and animals, excepting perhaps birds.

(b) Large tracts of the southern Western Ghats, in particular the inaccessible forested areas, remain unsurveyed by botanists and zoologists.

(c) In the case of much of the taxonomic work, collections were made during the last century, or during the early years of this century. Since then the habitat has been so drastically modified that the original type localities may not have the species at all. The status (whether the species is abundant, common, uncommon, rare, endangered or extinct) of a significant portion of the biota is unknown. Updating distributional field data, which needs to be constantly carried out, particularly in view of the extremely rapid destruction and modification of habitat, is grossly inadequate.

(d) In using species distribution data for preservation efforts, it is also necessary to have scientific data on the minimum population necessary for the species to survive genetically.

The earlier field surveys and taxonomic work, excepting in the case of birds and mammals, were random (both as to the region and as to the group). Many areas were covered extensively and repeatedly and many groups systematically. Many other areas, as well as many other groups, were altogether left out. For example, while extensive collections were made from all parts of the Nilgiri plateau, there has not been a single collection from the Camel's Hump Mountains. Similarly, while collections of birds and fresh water fishes were exhaustive, many other groups remain practically untouched. It is possible that many 'hot spots' for species diversity are left out. That this is particularly true with regard to the southern Western Ghats was well brought

out in the case of the Silent Valley Reserved Forest, from where during the 1975–89 period, through a number of scientific expeditions, an exceptionally rich assemblage of new species was identified.

Since basic distributional data on ecosystems or species are not available, totally different approaches will have to be tried for locating areas for long-term conservation.

5.3 Identification on the basis of edaphic conditions

Locating potential areas on the basis of topographic, bioclimatic and potential vegetation types is a practicable approach. Using available information on edaphic factors such as soil, slope, altitude, annual rainfall and duration of dry season, temperature regime, land use history, potential vegetation types, etc. It is possible to identify areas of priority or representative nature for the conservation of biological diversity.

5.4 Identification on the basis of feasibility of action

Taking into account the reality of the situation, since conservation of biological diversity occupies such low priority in the decision makers plans of action, it is needless to expect strong policy or financial support. Hence, it is worthwhile to attempt a plan of action wherein with minimal readjustments of boundaries and funding, the existing protected conservation areas can be made more effective in preservation as much of the spectrum of species diversity as possible.

From a different perspective also this is very necessary, because the existing unsystematically chosen bird sanctuaries, wildlife sanctuaries and national parks are held out as an objection against expansion of existing areas or additional locations being set aside for conservation purposes. Those objecting to conservation area expansion emphasize the exploitable resource loss. While invaluable areas remain without protection and are subjected to severe degradative influences, overworked and degraded areas are often set aside ostentatiously for conservation purposes. This needs to be rectified by a relative evaluation of all potential and existing conservation sites, and by suggesting specific modifications in their areas or boundaries to incorporate as much of areas of value as possible.

5.5 Topography and identification of area for the conservation of biological diversity

The configuration of the surface of land, i.e. ridges and valleys, steepness of the slope and aspect, elevation and ruggedness, etc. have an important bearing on living communities. Topography significantly influences micro and local climate and other physio-chemical environmental factors. Influencing the availability and distribution of water, so critical in controlling plant growth, is one obvious means by which topography decides the characteristics of plant communities. Since the Western Ghats receive only seasonal intense monsoon rainfall, the soil depth becomes most important

in deciding the types of vegetation. Valleys sheltered from the onslaught of rains and wind, where soils will also be deep, support the densest humid tropical vegetation. On the other hand, apart from lowering of temperature, elevation also results in greater wind velocities and higher evaporation and evapotranspiration loss and thus indirectly increase the physiological drought tendency.

Capacity of plants and plant communities to regenerate varies from location to location, depending on the physical environmental conditions. Areas above 1600–1800 m elevation in the Western Ghats have frost condition during winter nights, which greatly hinders germination and survival of seeds outside the shelter of natural climax forests.

The steepness of slope and degree of exposure enhances vulnerability of vegetation to damage. Since human intervention takes place practically in every part of the Western Ghats, damage to sensitive forests is often irreparable, creating more and more treeless areas.

5.6 Climate and vegetation

Although the entire southern Western Ghats falls within humid tropical climatic zone, there is considerable variation in the total annual rainfall and, more importantly, in its spread. While the southernmost part of the Western Ghats-Agasthyamalai receives in its southern extremity less than 1800 mm of rain, the Brahmagiri ghats in the Cannanore district of Kerala receives well over 5000 mm. But while Agasthyamalai Range has only two rainless months, Brahmagiris has five to six rainless months.

Similarly, from the coast across the ghats to the eastern foothills there is a distinct gradient in rainfall. Rainfall increases from west to east and reaches the highest values along the outermost western slopes of the main range, and then gradually recedes eastward to reach the lowest value at the eastern foot hill zone. But in the southernmost parts of the ghats, the equal influence of the north-east and south-west monsoons modifies this pattern.

On the basis of the available rainfall data there are seven loci of extreme heavy rainfall on the western slopes of the southern Western Ghats in Kerala, with an average annual rainfall of about 4500 mm. They are: (1) Aralam-Kottiyoor areas of the Brahmagiri slopes in the Cannanore district. (2) The Kuttiyadi-Vyttiri section of the south-western slopes of Wynad. (3) Western outer slopes of Silent Valley facing Nilambur plains (4) Sholayar-Karappara valleys in south-west Nelliampathies (5) A tract along the north-western edge of Idukky district extending from Pooyankutty to Neriyamangalam and Kaliyar in south (6) Lower Pamba Valley-Erumeli area (7) Chenduruny Valley—the upper reaches of Kulathupuzha.

Since the distribution of raingauges in very inadequate, especially in the inaccessible ghat slopes, rainfall figures are not sufficient. Yet, existing figures indicate rainfall of over 6000 mm in many locations. On the opposite extreme, rainfall of less than

900 mm/year has been recorded from the eastern edge of Attappady and Chinnar area on the north-eastern corner of Idukky district.

5.7 Topography

Taking into consideration the particular topography of the southern Western Ghats and its climate, and their influence on vegetation, potential locations with climax vegetation could be expected in sheltered valleys of less than 300 metre elevation.

5.7.1 *The Valleys*

Since the climax vegetation type in this part of the Ghats could have been low elevation wet evergreen forests, which have the richest assemblage of species from the point of view of conservation of biological diversity, remaining tracts of such forests have an important role. There are 32 such valleys in the southern Western Ghats on the western face. The southernmost two valleys are in the Kanyakumari district of Tamil Nadu, and the northernmost six are partly in Kerala and partly in Karnataka. Of the 32 valleys, 12 have been totally or heavily destroyed by irrigation and hydel reservoirs and power houses. Of these 8 have some residual forests with nominal protection. Teak and eucalyptus plantations have practically wiped out, or heavily damaged, natural vegetation in seven valleys. Encroachment and extensive agriculture have totally destroyed natural vegetation in four valleys, and partly destroyed in four valleys.

Of the northernmost five valleys, the lower reaches in Kerala have been totally deforested for agriculture in all the five. And of the Karnataka portion, forests remain to varying extents in four, of which one is under threat of submersion from a dam proposed in Kerala (the Kakkadavu irrigation project in Cherupuzha Valley), and one is heavily deforested for plantations.

In the entire reach of the Western Ghats in Kerala, extending over 500 km, only three valleys even now retain significant extent of forest vegetation. All the three are under imminent danger of submersion under reservoirs of hydel dams. They are (1) the Kallar Valley in Vamanapuram Basin under threat of submersion due to the Valayanki dam of the Vamanapuram irrigation project (2) the Pooyankutty Valley and (3) Pichchiyar Valley both under threat of submersion due to the Pooyankutty hydro-electric project.

There are six valleys below 600 m elevation on the eastern side of the Western Ghats, of conservation and biogeographic value. Of this all except one is in Tamil Nadu and the exception, Amaravathy valley, has a part of it (Chinnar Valley) in Kerala. The eastern parts of the Chinnar valley is in Tamil Nadu. The two southernmost valleys, viz. Manimuthar and Papanasam (treated here as one) have been destroyed due to dam construction, although they retain some valuable biota. The third Kambam Valley is disturbed by the power house of a hydroelectric project and extension of agriculture. Arjuna Valley has been heavily disturbed by extension of agriculture.

The remaining three, namely the Amaravathy Valley, Bolampatti Valley and Thadagam Valley have more of forest vegetation, although the Thadagam Valley has been disturbed by activities connected with the Siruvani dam.

5.7.2 *The higher reaches of the ghats*

As opposed to the low valleys, the highest reaches of the southern Western Ghats present a different picture. Inaccessibility, very heavy rainfall and harsh winter climate have kept at bay human settlements in these higher reaches. Ecologically, these are extremely fragile and any damage to their plant cover would result in the disappearance of vegetation to be succeeded by grasslands. The very discontinuous distribution of these high elevation regions automatically leads to discontinuous distribution of biota. In species isolation they function exactly like oceanic islands. These pockets of high elevation ecosystems, with their relict flora and fauna, warrant close study and protection.

Considering areas of 1500 metres and above m.s.l. the southern Western Ghats have two major extensive high elevation areas—namely the Nilgiri plateau and the Anamalai-High Range-Palni complex. There are also five distinct clusters of much smaller high elevation regions.

Excepting two or three individual peaks, such as the Brahmagiri Peak, Mottearamane, Somamala etc. the southern Brahmagiris has no high altitude area. The western edge of the Wynad plateau again has two or three individual peaks going up above 1500 metres, viz. Banasuramkotta, Kurichiyarmala, etc. On the south-western edge of Wynad, on the Camel's Hump Mountains, there are a number of peaks going up above 1500 metres and some up to 2000 metres. Inaccessibility has helped preserve comparatively more unmodified forest vegetation in this ridge than anywhere else mentioned until now.

The Nilgiri plateau is a large tableland extending over 2000 sq.km. Human settlements, deforestation and other man-made changes have practically totally destroyed or modified all the ecosystems, excepting along the edges of the scarps, in particular along the south-western corner of Nilgiris overhanging the Nilambur Valley and Attappady. The western edge of the Nilgiris along the Kerala border that is the Kunda Range, and the Korakunda Range, and the south-west corner alone have fairly extensive high elevation ecosystems remaining undisturbed. The Sispara pass located at the junction of the Kunda and the Korakunda ranges on the edge of the Silent Valley forests also is one of the richest known areas for high elevation flora in the southern Western Ghats.

South of Nilgiris, but still north of the Palghat Gap, there is an almost intact island of high elevation ecosystem extending along the Siruvani-Elival-Palamala-Karimala range of hills. This area is also well known for the number of plants endemic to this region.

South of the Palaghat Gap, there is a second extensive tableland of about 2000

sq.km, falling mostly within Tamil Nadu and partly in Kerala. It includes part of the Anamalais, Grass Hills, extensive areas of the High Ranges and the entire Palni (Kodaikanal) upper reaches. Although some parts, for example, most of the Kodaikanal plateau, are very heavily degraded, many other areas, for example the Eravikulam plateau and the adjacent Grass Hills, still have some undisturbed ecosystems.

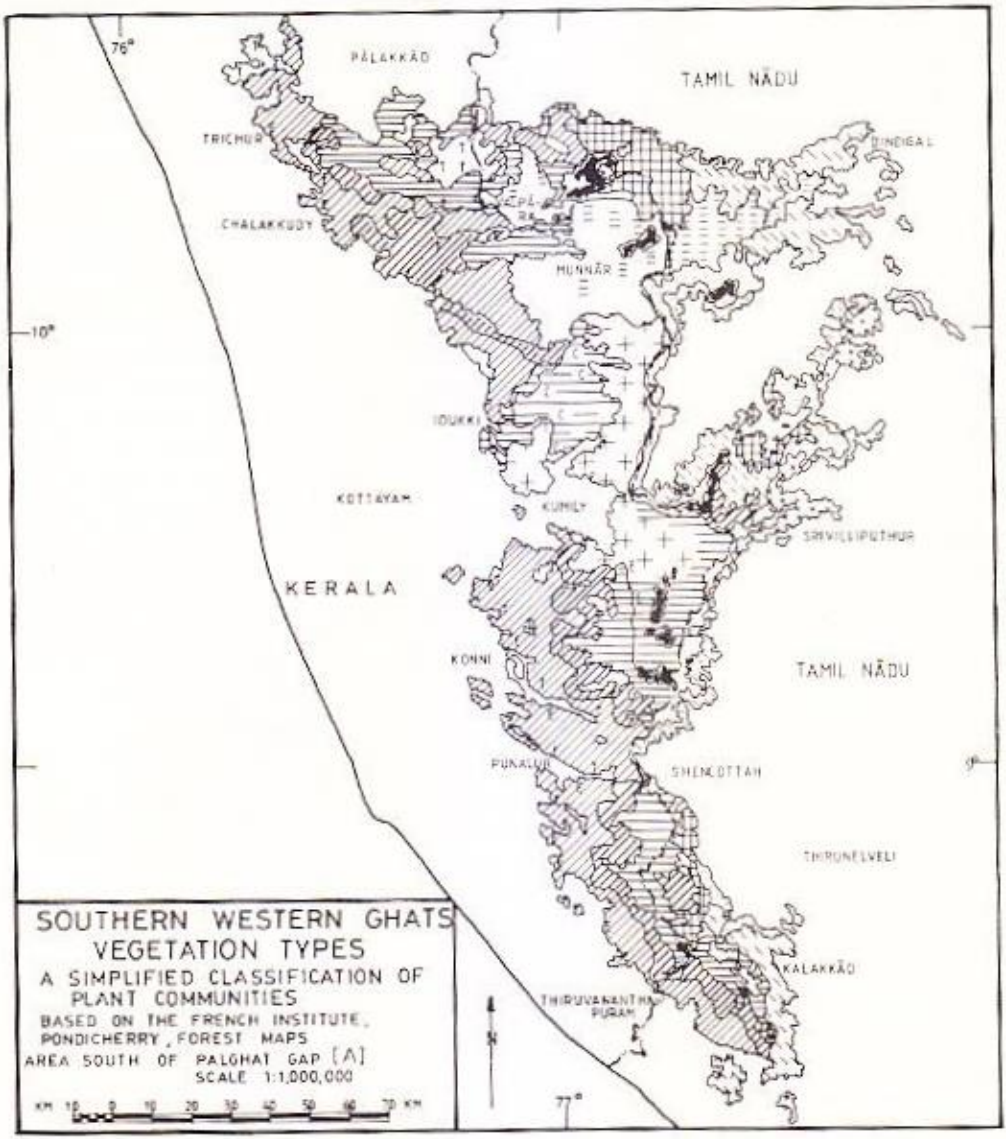
The next southern and perhaps the least disturbed cluster of high elevation ecosystems are in the Pandalam Hills and the High Wavies (Varushanad Hills). Although this area does not have extensive areas of the typical shola-grassland ecosystem of the Nilgiris or the Palnis, it has extensive pristine forest tracts above 1500 metre elevation. There are three different ridges in this region with a number of peaks going upto 1800 metres and above m.s.l. The High Wavies or the Varushanad Hills has maximum high elevation area, but a large number of coffee, tea and cardamom plantations have fragmented the habitat extensively. Next is the ridge which forms the state boundary, known as the Sivagiri Range, which is also the eastern watershed boundary of Periyar. Excepting for more than a dozen small cardamom leases on the eastern (Tamil Nadu) slope of this ridge it is totally undisturbed. The third ridge with high elevation evergreen forests extends north-south parallel to the Sivagiri range, but to the west of it, forming the watershed line between Pamba and Periyar. It is an uninhabited and totally undisturbed area which has perhaps the best preserved forest remaining in the entire southern Western Ghats south of the Palghat gap.

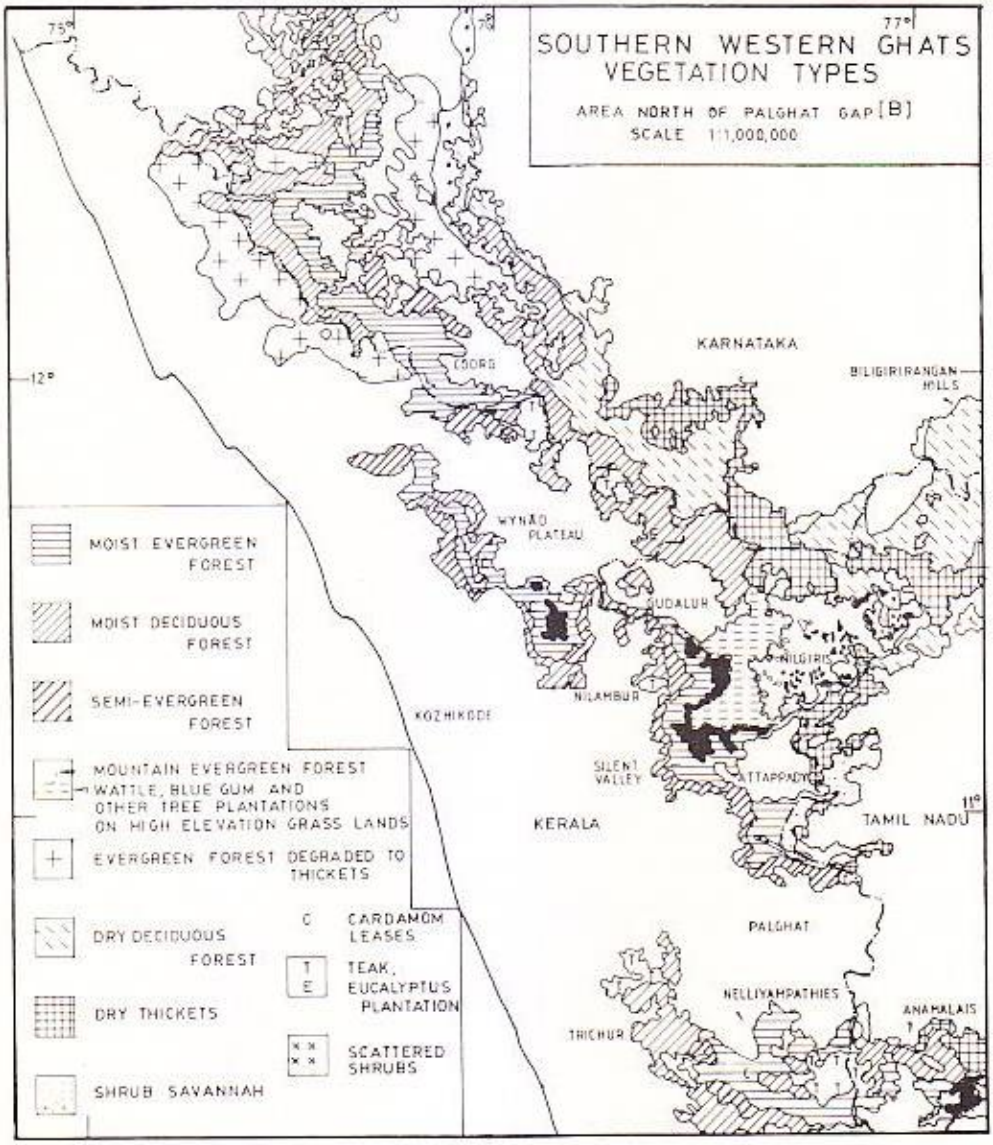
The last cluster of high elevation vegetation in the southern Western Ghats is the Agasthyamalai Range. There are four small regions, of which the two smallest are at the head of the Chenduruny Valley along the state border, while the third is around the Agasthyamalai peak and the fourth, the most extensive area, is along the Kalakkad and Mahendragiri hills.

5.8 Conservation of biological diversity through the conservation of forests

One approach for the identification of representative ecosystem areas in the Western Ghats in Kerala is to locate the remaining areas of forest types, including edaphic and seral stages. Identifying viable units containing such a range of natural distribution grouping is one measure for preserving benchmark areas.

The extent of damage the forest ecosystems of the southern Western Ghats in Kerala have suffered in recent years is so severe that it is uncertain whether in the case of some even a single representative area, or, in the case of many, a viable unit of such an area survives today. Many of the sub-types and seral stages of vegetation are transitional phases in plant community evolution and in time, if left undisturbed, they evolve into a different identity. Our current understanding of plant community evolution is inadequate to trace such courses of change and pinpoint representative locations. Some of these sub-types are ecotonal areas and changes taking place in either of the ecosystems will influence the characteristic of the ecotone.


SOUTHERN WESTERN GHATS
VEGETATION TYPES
A SIMPLIFIED CLASSIFICATION OF
PLANT COMMUNITIES
BASED ON THE FRENCH INSTITUTE,
PONDICHERRY, FOREST MAPS
AREA SOUTH OF PALGHAT GAP (A)
SCALE 1:1,000,000
KM 10 0 10 20 30 40 50 60 70 KM
76°
77°
10°
9°
PALAKKAD
TAMIL NADU
TRICHUR
ERNAKULAM
CHALAKKUDY
MUNNAR
IDUKKI
KOTTAYAM
KUMILY
SRIVILLIPUTHUR
KERALA
KONNI
TAMIL NADU
PUNALUR
SHENKOTTAH
TIRUNELVELI
KALAKKAD
THIRUVANANTHA PURAM


SOUTHERN WESTERN GHATS
VEGETATION TYPES
AREA NORTH OF PALGHAT GAP (B)
SCALE 1:1,000,000
75°
77°
12°
11°
KARNATAKA
COORG
BILIGIRIRANGAN HILLS
WYNAD PLATEAU
GUDALUR
NILGIRI
NILAMBUR
KOZHIKODE
SILENT VALLEY
ATTAPPADY
KERALA
TAMIL NADU
PALGHAT
NELLIYAMPATHIES
ANAMALAIS
TRICHUR
MOIST EVERGREEN FOREST
MOIST DECIDUOUS FOREST
SEMI-EVERGREEN FOREST
MOUNTAIN EVERGREEN FOREST
WATTLE, BLUE GUM AND OTHER TREE PLANTATIONS ON HIGH ELEVATION GRASS LANDS
EVERGREEN FOREST DEGRADED TO THICKETS
DRY DECIDUOUS FOREST
DRY THICKETS
SHRUB SAVANNAH
C CARDAMOM LEASES
T E TEAK, EUCALYPTUS PLANTATION
SCATTERED SHRUBS

A very detailed ground survey is essential to locate the best representative areas of these vegetation types, and the edaphic and seral stages. It is also to be remembered that using the forest vegetation types as a guideline for ecosystem preservation is applicable only in the ghat areas, and not for the coastal or wetland ecosystems in the state.

Since the word 'forest' is used to imply different shades of meaning in different contexts, the important current definitions are given below:

FAO in *World Forest Inventory* (1960) defines forests as "all lands bearing vegetation associations dominated by trees of any size, exploited or not, capable of producing wood or exerting an influence on the local climate or on the water regime or providing shelter for livestock and wildlife".

Willis (1951), on the other hand, defines forests as "a closed assemblage of trees, allowing no break in the overhead canopy, homogeneous of one species or diversified" In the context of this study, what is dealt with under the Western Ghats forests, transcends the above given second definition of forests, and is closer to an ecological definition which says: "forests are complexes of plant communities or vegetation formations that have evolved over time according to biological laws and not a random aggregation of plants".

In legal terminology a forest is "an area of land proclaimed to be a forest under a Forest Law". According to the Indian Forest Code, a forest is "an area set aside for the production of timber and other forest produce, or maintained under woody vegetation for certain indirect benefits which it provides e.g. climatic or protective"

5.8.1 *Vegetation classification*

Earlier attempts to classify the Indian vegetation were primarily classifications of forest types on the basis of forest working plan data, where the emphasis was only on the relative abundance of forest trees of timber value. In such attempts, although broad outlines of groups of forest vegetation are laid down, identity of distinct plant communities reflecting evolutionary, successional, edaphic and locational details are unaccounted for. This is partly due to the extent of the spatial unit area taken up (scale of classification), and partly due to the fact that the entire spectrum of vegetation is not being taken into account for categorising it. In forestry science (forests account for about 25 percent of the land area of the country) the classification of forest vegetation even now followed is that of Champion and Seth (1968).

5.8.1.1 *Forest vegetation types of southern Western Ghats of Kerala. (Champion and Seth).*

MOIST TROPICAL FORESTS

Group 1—Tropical wet evergreen forests

Sub group 1A—Southern Tropical Wet Evergreen forests

C3	Southern Hill topevergreen forest	1A/C3
C4	West coast tropical evergreen forest	1A/C4

Edaphic and Seral Types

E1	Cane Brakes	1A/E1
E2	Wet bamboo brakes	1A/E2
2S1	Pioneer euphorbaceous scrub	1A/2 S1

Group 2—Tropical semi-evergreen forest

Sub group 2A—Southern tropical semi-evergreen forest

C2	West Coast semi-evergreen forest	2A/C2
C3	Tirunelveli semi-evergreen forest	2A/C3
2S1	West Coast secondary evergreen dipterocarp forests	2A/2 S1

Edaphic and Seral Types

E1	Cane brakes	2A/E1
E2	Wet bamboo brakes	2A/E2
E3	Moist bamboo brakes	2A/E3
E4	Lateritic semi-evergreen forest	2A/E4

Group 3—Tropical moist deciduous forest

Sub group 3B—South Indian moist deciduous forest

C1	Moist teak bearing forest	3B/C1
C1*a*	Very moist teak forest	3B/C1a
C1*b*	Moist teak forest	3B/C1b
C1*c*	Slightly moist teak forest	3B/C1c
C2	Southern moist mixed deciduous forest	
2S2	Southern Secondary moist mixed deciduous forest	3B/C2/2S2

GROUP 4—LITTORAL AND SWAMP FORESTS

Sub group 4C—Tropical fresh water swamp forest

FS1	Myristica Swamp forest	4C/FS1
FS2	Tropical hill valley swamp forest	4C/FS2

Sub group 4E—Tropical Riparian fringing forest

RS1	Riparian fringing forest	4E/RS1
RS2	Dry tropical riverine forest	4E/RS2
E7	Laterite Scrub	4E/E7

MONTANE SUB-TROPICAL FOREST

GROUP 8—SUB-TROPICAL BROAD LEAVED HILL FORESTS

Sub group 8A—Southern sub-tropical broad leaved hill forests

C1	Southern sub-tropical hill forest	8A/C1
DS1	South Indian sub-tropical hill savanna (Woodland)	8A/DS1
E1	*Ochlandra*-Reed brakes	8A/E1

GROUP 11—MONTANE WET-TEMPERATE FOREST

Sub group 11A (Type C1)—Southern montane wet temperate forest		11A/C1
DS1	Southern montane wet scrub	11A/DS1
DS2	Southern montane wet grassland	11A/DS2

The Champion and Seth Classification of forest vegetation has been modified and elaborated by C. Chandrasekharan (1962) for Kerala on the basis of much more detailed locational information.

5.8.1.2 *Forest Types of Kerala State (C. Chandrasekharan, 1962)*

GROUP 1—TROPICAL WET EVERGREEN FOREST

Climax forest types:

1. C1 Low level evergreen forests
2. C2 High level evergreen forests
3. C3 'Low' tropical ghat evergreen forests

Secondary forest types

4. S1 Semi evergreen (secondary) forests
5. S2 Secondary evergreen forests
6. S3 Moist deciduous (secondary) forests
7. S4 Open deciduous forests
8. S5a Wet Bamboo (reed) brakes
9. S5b Moist bamboo (*Bambusa*) brakes
10. S6 Low level grasslands

Edaphic forest types

11. E1 Myristica swamps
12. E2 Tropical valley fresh water swamps
13. E3 Tropical riverine forests
14. E4 Cane brakes
15. E5 *Xylia* mixed forests
16. E6 Laterite scrub

GROUP II—TROPICAL MOIST DECIDUOUS FOREST

Climax forest types

17. G1 Wynad plateau deciduous forests
18. G2 Moist mixed deciduous forests

Secondary forest types

19. S1 Moist savannah
20. S2 Secondary forest with bamboo

Edaphic forest types

21. E1 Post-climax evergreen forests

GROUP III—TROPICAL DRY DECIDUOUS FOREST

Climax forest types

22. C1 Tropical dry deciduous forests
23. C2 Mixed dry deciduous forests with sandal

Secondary forest types

24. S1 Dry savannah

GROUP IV—MONTANE SUBTROPICAL FORESTS

Climax forest types

25. C1 Subtropical wet hill forests

GROUP V—MONTANE TEMPERATE FORESTS

Climax forest types

26. C1 Wet temperate forests

Secondary forest types

27. S1 High level (montane) grasslands

Note : C–Climate climax S–Secondary E–Edaphic

The distribution of the different vegetation types show a clear relationship to elevation. On the western slopes of the ghats, rainfall, strictly speaking, is not a limiting factor in the succession towards the climax. On the other hand, the increasing duration of the dry season from south to north has the decisive influence. The mean lowest temperature in the winter months, to an extent, is also a limiting factor, since frost inhibits germination of evergreen species. Corresponding with the altitude, the wind velocity also exerts a significant controlling influence on the vegetation, through modifying evapo-transpiration as well as by the mechanical impact on the plant community.

The shola forests normally occur above 1800 metres and the evergreen forests from 1800 metres down to 600 metres elevation. The moist deciduous forests occur below the evergreen belt on the western slopes. On the eastern slopes, instead of moist deciduous forests, dry deciduous forests are found.

5.9 Biogeographic regions and vegetation types within the southern Western Ghats of Kerala

Area classification for long-term conservation based on Gadgil and Meher-Homji.

Madhav Gadgil and Meher-Homji have classified the forest ecosystems of southern Western Ghats on a wider range of criteria, apart from vegetation types, including bioclimatic details. A summary of locational details as per this classification of the

southern Western Ghats of Kerala is presented below:

I

1.	Biogeographic region	: Wet evergreen forest of west coast Western Ghats.
2.	Vegetation type	: *Cullenia-Mesua-Palaquium*.
3.	Geographical range	: Western side of the Western Ghats in Kerala northward upto Wynad, normally above 600 m elevation.
4.	Annual rainfall (in mm)	: >3000
5.	No. of dry months	: <4
6.	Mean temperature of the coldest month (in °C)	: >20
7.	No. of major patches	: 8
8.	Major nature reserves currently existing	: Chenduruny Wildlife Sanctuary, Periyar Tiger Reserve, Silent Valley National Park.
9.	Key areas for long-term preservation	: 1. Pandalam Hills (catchment of the Pamba River) : 2. Pooyankutty—Idamala Valleys 3. Sholayar—Nelliampathies 4. New Amarambalam Reserved Forest
10.	Potential area under this vegetation type in the State	: 1500 sq.km

II

1.	Biogeographic region	: Wet evergreen forest of west coast Western Ghats.
2.	Vegetation type	: *Dipterocarpus-Mesua-Palaquium*.
3.	Geographical range	: North end of Wynad—Brahmagiri slopes upto 1500 M. elevation.
4.	Annual rainfall (in mm)	: >2000
5.	No. of dry months	: 4–5
6.	Mean temperature of the coldest month (in °C)	: >15
7.	No. of major patches	: 2
8.	Major nature reserves currently existing	: None
9.	Key areas for long-term preservation	: Thirunelli—Kottiyoor Reserved Forests
10.	Potential area under this vegetation type in the State	: 200 sq.km

III

1.	Biogeographic region	: Wet evergreen forest of west coast Western Ghats.
2.	Vegetation type	: Montane Shola
3.	Geographical range	: High peaks along the entire length of the Western Ghats reaching above 1800 m. Extensive areas in High Ranges and Nilgiri western edges.
4.	Annual rainfall (in mm)	: 2000–3000
5.	No. of dry months	: 0–4
6.	Mean temperature of the coldest month (in °C)	: >10
7.	No. of major patches	: 7
8.	Major nature reserves currently existing	: 1. Periyar Tiger Reserve : 2. Eravikulam National Park 3. Silent Valley National Park
9.	Key areas for long-term preservation	: In addition to areas given above : 1. Camel's Hump Mountains 2. Scattered Shola forests in the High Range area
10.	Potential area under this vegetation type in the State	: <400 sq.km

IV

1.	Biogeographic region	: Wet evergreen teak ecotone.
2.	Vegetation type	: *Tectona-Lagerstroemia-Dillenia-Terminalia paniculata.*
3.	Geographical range	: On the Western side of the Western Ghats below the evergreen-wet evergreen belt and along the plains.
4.	Annual rainfall (in mm)	: 4000–8000
5.	No. of dry months	: 3–7
6.	Mean temperature of the coldest month (in °C)	: >15
7.	No. of major patches	: 6
8.	Major nature reserves currently existing	: 1. Parambikulam Wildlife Sanctuary : 2. Wynad Wildlife Sanctuary 3. Peechi-Vazhani Wildlife Sanctuary 4. Chimmony Wildlife Sanctuary
9.	Key areas for long-term preservation	: 1. Lower reaches of Kallar Valley in Pandalam Hills : 2. Nelliampathy western slopes 3. Nilambur Valley
10.	Potential area under this vegetation type in the state	: <200 sq.km

V

1.	Biogeographic region	: Teak Zone
2.	Vegetation type	: *Anogeissus-Terminalia-Tectona*.
3.	Geographical range	: On the eastern slopes of Western Ghats. From Kanyakumari to Jhansi. In Kerala, limited to the Anjanad Valley, eastern parts of Attappady Valley and eastern parts of Wynad. Below 1000 m. elevation.
4.	Annual rainfall (in mm)	: 800–1800
5.	No. of dry months	: 6–8
6.	Mean temperature of the coldest month (in °C)	: >15
7.	No. of major patches	: 2
8.	Major nature reserves currently existing	: 1. Chinnar Wildlife Sanctuary : 2. Wynad Wildlife Sanctuary
9.	Key areas for long-term preservation	: —do—
10.	Potential area under this vegetation type in the state	: <80 sq.km

CHAPTER SIX

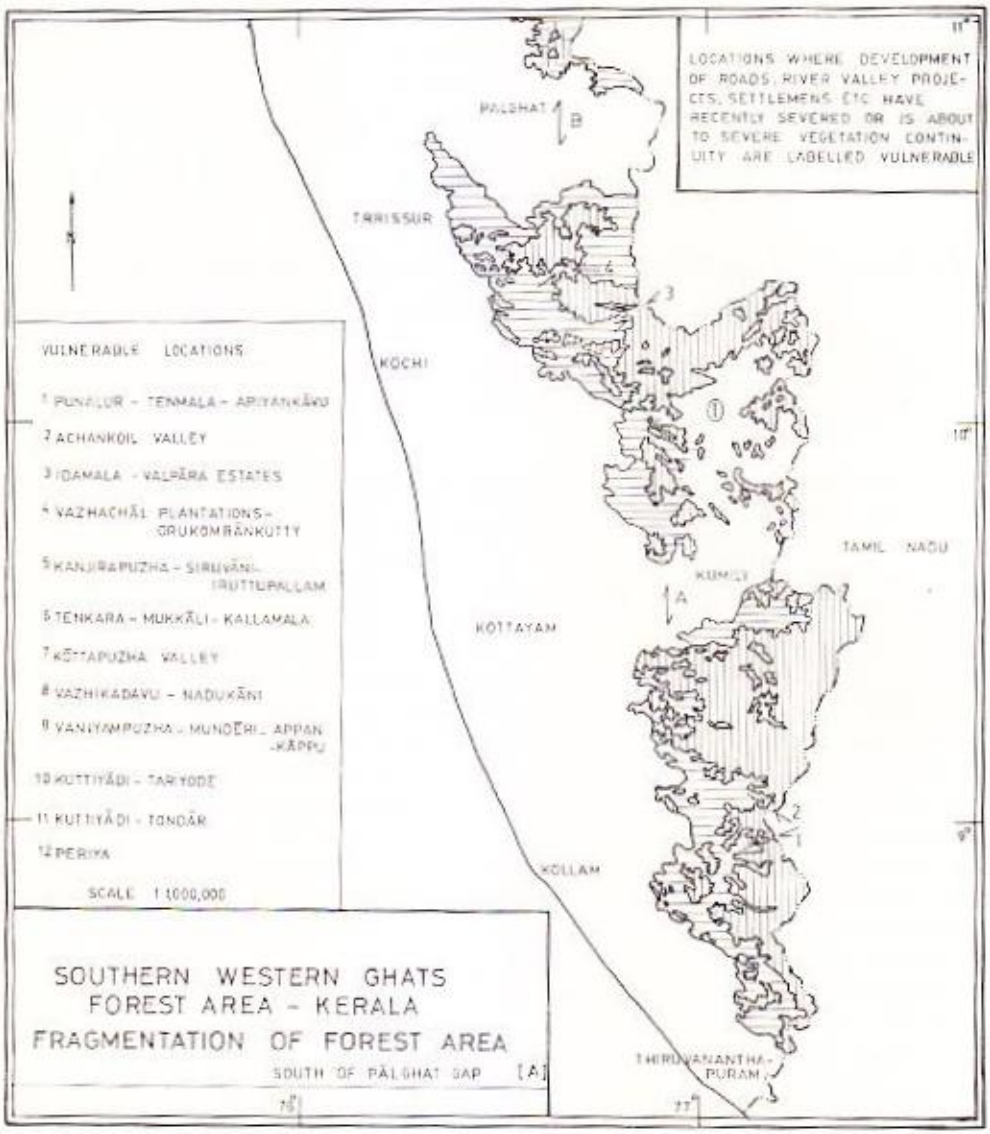
The Remaining Forests: the Choice of Areas for long-term Conservation

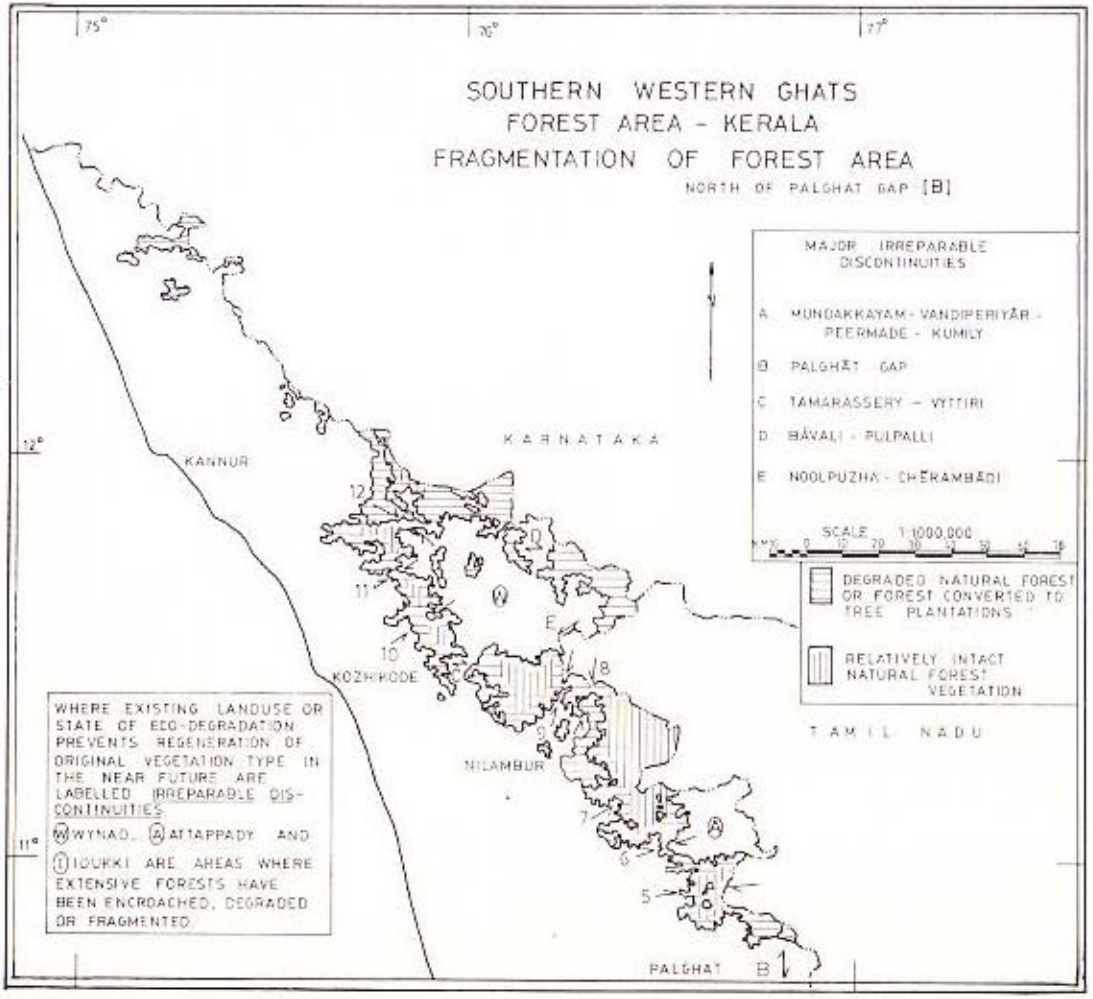
6.1 Forest destruction in southern Western Ghats

In Kerala, reduction in the extent of forest has been extremely rapid. In the absence of a system of maintaining continuous forest inventories this leads to considerable confusion and faulty planning. While a considerable extent of forests has been legally or illegally cleared, a far larger area has been degraded to ecologically non-forest areas.

The latest detailed resource survey of forests in Kerala was carried out in 1970 and the results published in 1973 (C. Chandrasekharan), according to which the total forest area of the state was 9400 sq.km. But the administrative report of the forest department gives the figure of 11,320 sq.km of which 9161 sq.km was shown as reserved forest and the rest vested forests. Records of the forest department show the total forest area as 12,360 sq.km. Since a considerable area has been given away, encroached, and diverted for non-forestry purposes, even the figure of 9400 sq.km for 1970 is high. The discrepancies in figures are due to the fact that forest resurveys have not been carried out to account for changes, i.e. reduction of area since the issue of reserve notifications, which was mostly at the turn of this century. The area alienated to various public sector corporations such as the Forest Development Corporation, Plantation Corporation, Farming Corporation, Rehabilitation Corporation, Oil Palm India Ltd., etc. and the area submerged under the reservoirs are not de-reserved and this inflates the figure of the actual extent of forest.

There have been too few studies on the extent of forests in Kerala, the rate of deforestation, causes of deforestation and the history of encroachment of forest lands, etc. On the basis of comparison of topographical maps of 1905 and the landsat imageries of 1973, Chattopadhyay (1985) showed that only 9 to 10 percent of the total geographical area of the state remains under natural vegetation cover with intact


LOCATIONS WHERE DEVELOPMENT OF ROADS, RIVER VALLEY PROJECTS, SETTLEMENTS ETC. HAVE RECENTLY SEVERED OR IS ABOUT TO SEVERE VEGETATION CONTINUITY ARE LABELLED VULNERABLE
PALGHAT
TRISSUR
KOCHI
KOTTAYAM
KOLLAM
TAMIL NADU
KUMILI
THIRUVANANTHAPURAM
VULNERABLE LOCATIONS
1 PUNALUR - TENMALA - ARIYANKAVU
2 ACHANKOIL VALLEY
3 IDAMALA - VALPARA ESTATES
4 VAZHACHAL PLANTATIONS - ORUKOMBANKUTTY
5 KANJIRAPUZHA - SIRUVANI - THUTTUPALLAM
6 TENKARA - MUKKALI - KALLAMALA
7 KOTTAPUZHA VALLEY
8 VAZHIKADAVU - NADUKANI
9 VANIYAMPUZHA - MUNDERI - APPAN - KAPPU
10 KUTTIYADI - TARIYODE
11 KUTTIYADI - TONDAR
12 PERIYA
SCALE 1:1000,000
SOUTHERN WESTERN GHATS
FOREST AREA - KERALA
FRAGMENTATION OF FOREST AREA
SOUTH OF PALGHAT GAP [A]


SOUTHERN WESTERN GHATS
FOREST AREA - KERALA
FRAGMENTATION OF FOREST AREA
NORTH OF PALGHAT GAP [B]
75°
76°
77°
12°
11°
KARNATAKA
KANNUR
KOZHIKODE
NILAMBUR
PALGHAT
TAMIL NADU
MAJOR IRREPARABLE DISCONTINUITIES
A MUNDAKKAYAM - VANDIPERIYAR - PEERMADE - KUMILY
B PALGHAT GAP
C TAMARASSERY - VYTTIRI
D BAVALI - PULPALLI
E NOOLPUZHA - CHERAMBADI
SCALE 1:1000,000
DEGRADED NATURAL FOREST OR FOREST CONVERTED TO TREE PLANTATIONS
RELATIVELY INTACT NATURAL FOREST VEGETATION
WHERE EXISTING LANDUSE OR STATE OF ECO-DEGRADATION PREVENTS REGENERATION OF ORIGINAL VEGETATION TYPE IN THE NEAR FUTURE ARE LABELLED IRREPARABLE DISCONTINUITIES.
(W) WYNAD, (A) ATTAPPADY AND (I) IDUKKI ARE AREAS WHERE EXTENSIVE FORESTS HAVE BEEN ENCROACHED, DEGRADED OR FRAGMENTED.

forest, while the official figure was 24 percent. During the initial period, extending over 50 to 60 years from 1905 to 1965, the depletion rate was 0.27 percent per year (i.e. about 106.57 sq.km/year). In the second period, of 8 to 10 years from 1965 to 1973, the annual rate of depletion was 246.32 sq.km/year i.e. one percent of the total geographical area.

TABLE 1 : DEFORESTATION TREND

	Area under forest		*Depletion*	
	sq.km	*percentage*	*sq. km*	*percentage*
1905	17120.82	44.07		
1965	10726.56	27.41	6394.26	16.36
1973	6627.72	17.06	4098.84	10.65
	Total geographic area of the state 38854.97 sq.km.			

Source : S. Chattopadhyay (1985)

A detailed field survey of Trivandrum Forest Division area for field check substantiated the statewide trend and showed that deforestation trend is continuing almost unabated.

TABLE 2 : TREND TOWARDS DEFORESTATION IN TRIVANDRUM DISTRICT

	Area under forest percent of total geographic area	*percentage decrease*
1905	36.88	13.82
1965	23.06	13.82
1973	13.65	9.21
1984	8.71	5.14

Source : S. Chattopadhyay (1985)

A comparable study in the Trichur Forest Division by A.R.R. Menon (1986) showed that between 1930 and 1960, 23 percent of the forest area was cleared in that forest division and between 1960 and 1984 the rate doubled to 50 percent. While on record the Trichur Forest Division covers about 150 sq.km, in 1930 it is estimated to have been 392 sq.km. Even in the remaining area, 23 sq.km, i.e. 15 percent of the remaining reserved forests is so badly degraded, being located along the perimeter

of the forests, that it cannot be considered as forests functionally. This leaves only 130 sq.km in Trichur Forest Division. This report does not mention the potential climax vegetation of the forest division according to topography and edaphic factors as against the types of existing vegetation, indicating the extent of degradation affecting the whole division.

The National Remote Sensing Agency (NRSA) conducted a study to map the forest cover in India from satellite imageries, and also attempted to estimate the reduction in area between the period 1972–75 and 1980–82. This study showed that while in the 1972–75 period, the state of Kerala had 8611 sq.km of forests (22.15 percent of the total geographical area) by 1980–82, it had been reduced to 7370 sq.km (18.98 percent of the geographical area). In other words in less than 10 years time, 1235 sq.km of forests which is 3.17 percent of the total geographical area, had been deforested. During the same period the rate of deforestation for the whole country was 2.79 percent.

The NRSA again conducted a study in 1987, mapping the forests of Kerala using remotely sensed imageries for the years 1982, 1983–84, 1984–85 and 1985–86. This study reported that within the reserved forest boundary, forest recession had tapered off.

TABLE 3 : PERCENT COVER OF NATURAL FOREST FOR ENTIRE STATE AND OTHER CATEGORIES IDENTIFIED WITHIN RESERVED FOREST BOUNDARIES

Categories	*1982*	*1983–84*	*1984–85*	*1985–86*
Total dense forest in the state	17.40	17.31	17.25	17.23
Total open forest in the state	1.57	1.58	1.58	1.58
Total scrub in the state	0.89	0.84	0.78	0.78
Grassland, rock outcrop within R.F. boundary	0.74	0.74	0.74	0.70
Rubber within R.F. boundary	0.72	0.74	0.75	0.76
Other plantations within R.F. boundary	2.68	2.71	2.70	2.72
Other landuse/land cover within boundary	4.37	4.48	4.58	4.63

Source : NSRA (1987)

Though the slowing down of the rate of deforestation is heartening, the study of the NRSA cannot hope to reflect accurately the ongoing ecodegradation, which has a latency period before becoming apparent. In the interpretation of imageries three forest types have been distinguished.

1. The dense forest (with more than five metre high trees and a crown density of more than 40 percent).
2. The open forest (with trees more than five metre in height and a crown density of 10 to 40 percent).

FORESTS OF LONG TERM CONSERVATION POTENTIAL
ASHAMBU HILLS (AGASTHYAMALAI)

MAP 1

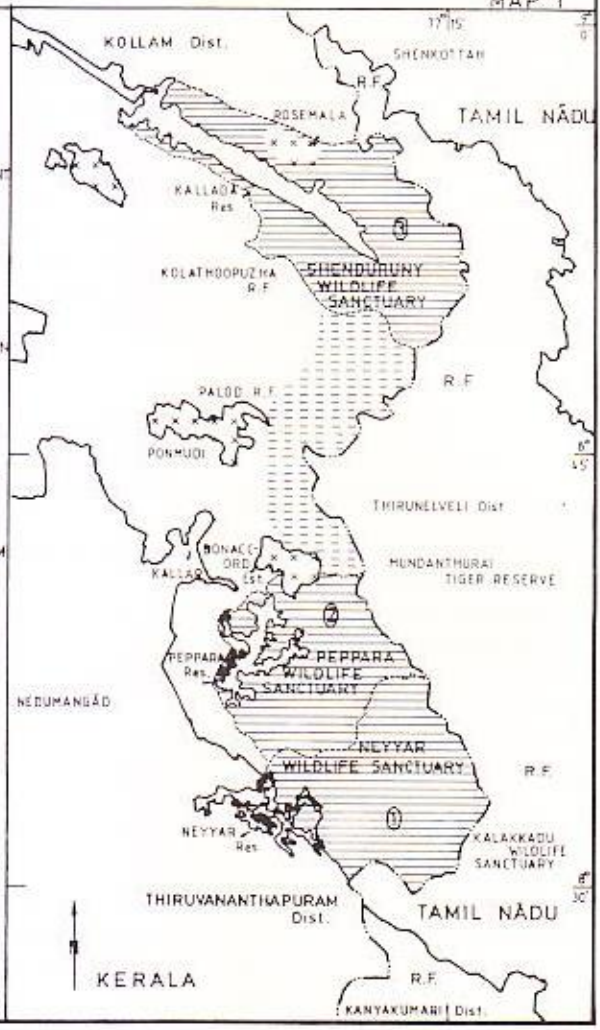
REFERENCES
(COMMON FOR MAPS 1 TO 8)

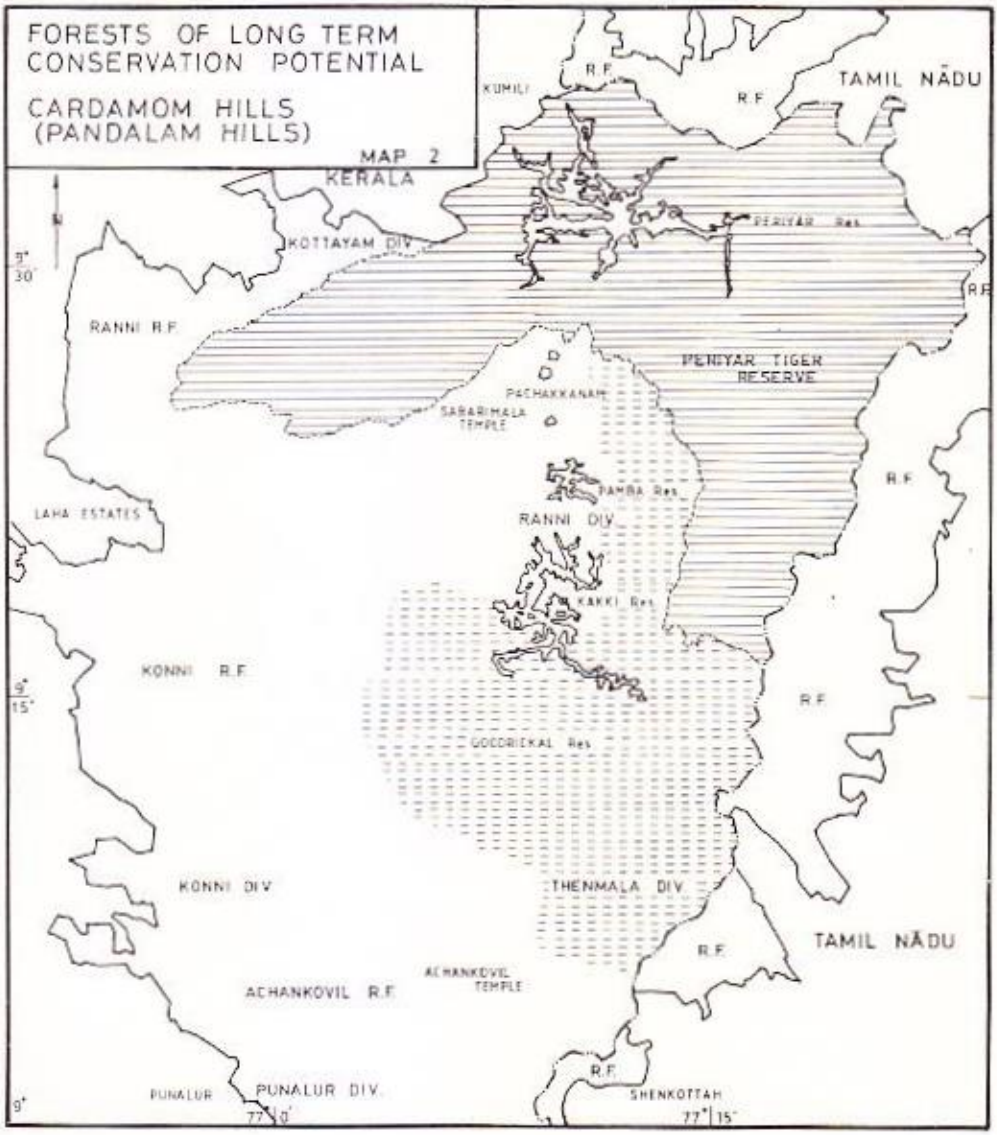
- STATE BOUNDARY
- FOREST BOUNDARY
- R.F. RESERVED FOREST
- ENCLOSURE/TRIBAL SETTLEMENT ESTATE ETC.
- Res. RESERVOIR
- PROTECTED AREA (NATIONAL PARK AND SANCTUARY)
- VESTED FOREST BOUNDARY (APPROXIMATE)
- INTACT FOREST VEGETATION SUITABLE FOR PRESERVATION

SOME OF THE PLACE NAMES IN KERALA HAVE BEEN OFFICIALLY CHANGED RECENTLY. THE MAPS MAY HAVE EITHER OF THE NAMES

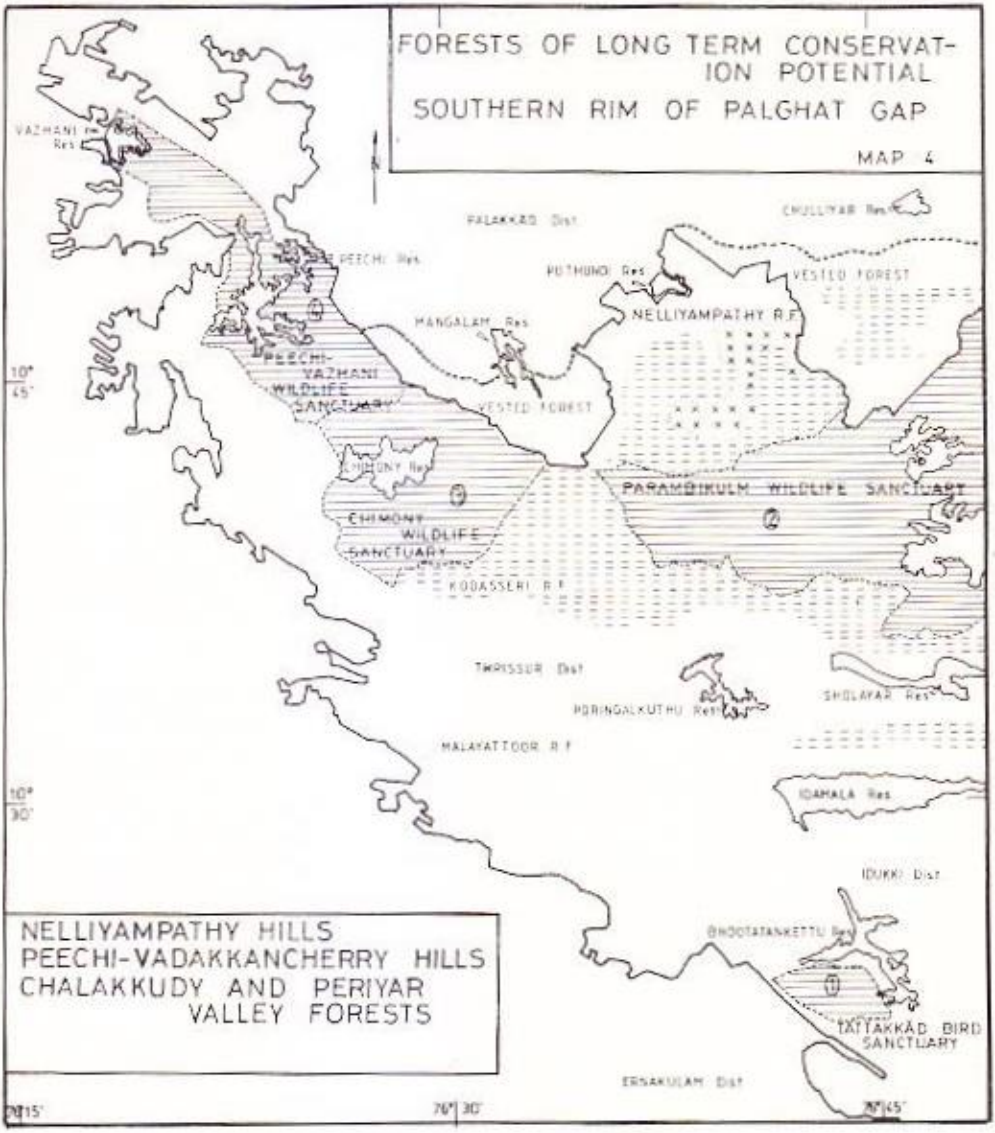
OLD	NEW
TRIVANDRUM	THIRUVANANTHAPURAM
QUILON	KOLLAM
COCHIN	KOCHI
TRICHUR	THRISSUR
PALGHAT	PALAKKAD
CALICUT	KOZHIKODE
CANNANORE	KANNUR

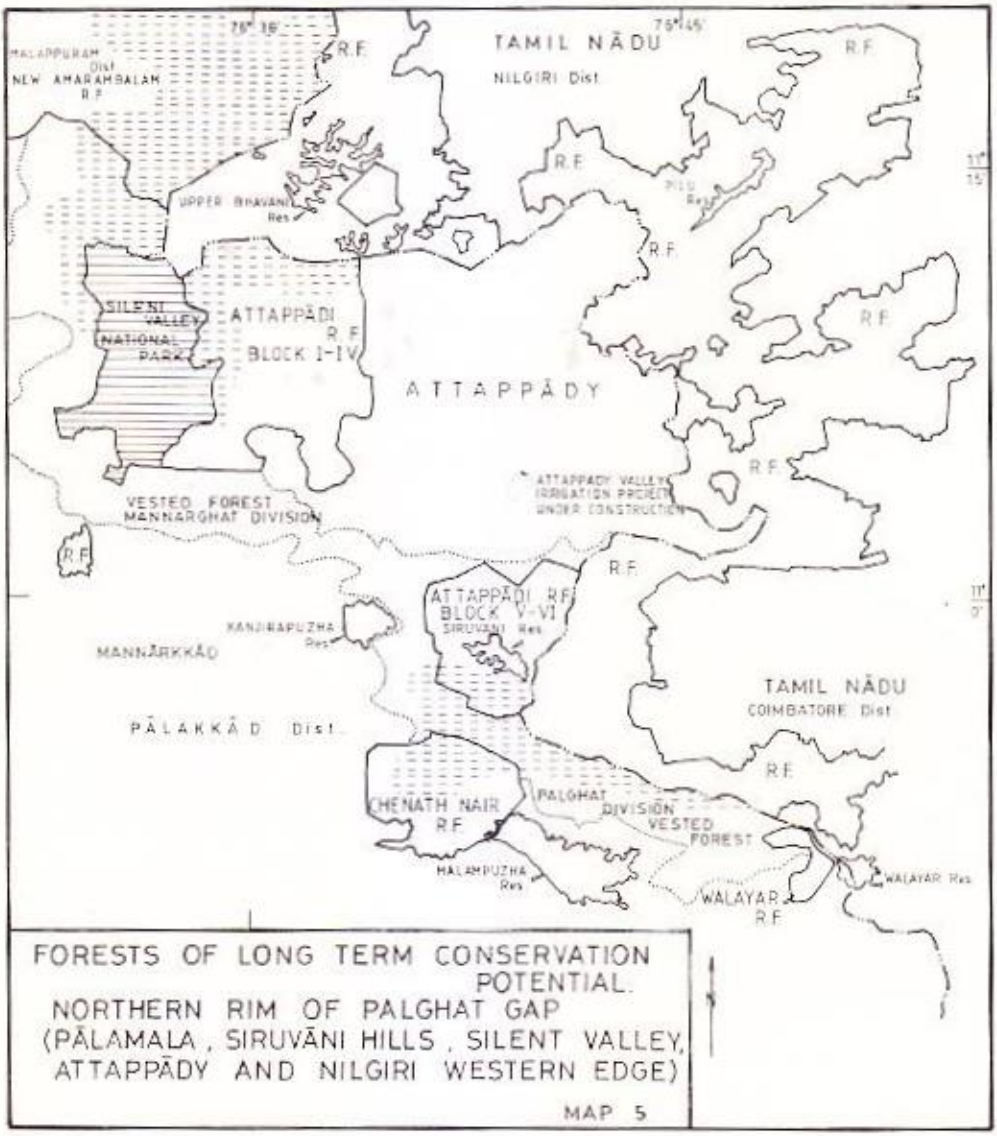
ALL MAPS IN THIS SERIES (1 to 8) ARE OF THE SAME SCALE -
1: 250,000
2500m to 1cm
0·4cm to 1km
Km 5 0 5 10 15




FORESTS OF LONG TERM CONSERVATION POTENTIAL
CARDAMOM HILLS (PANDALAM HILLS)
MAP 2
KERALA
TAMIL NĀDU
KUMILI
R.F.
R.F.
PERIYAR Res.
KOTTAYAM DIV.
RANNI R.F.
PERIYAR TIGER RESERVE
PACHAKKANAM
SABARIMALA TEMPLE
PAMBA Res.
RANNI DIV.
LAHA ESTATES
KAKKI Res.
KONNI R.F.
GODDRIEKAL Res.
KONNI DIV.
THENMALA DIV.
ACHANKOVIL TEMPLE
ACHANKOVIL R.F.
PUNALUR
PUNALUR DIV.
SHENKOTTAH
9° 30'
9° 15'
9°
77° 0'
77° 15'

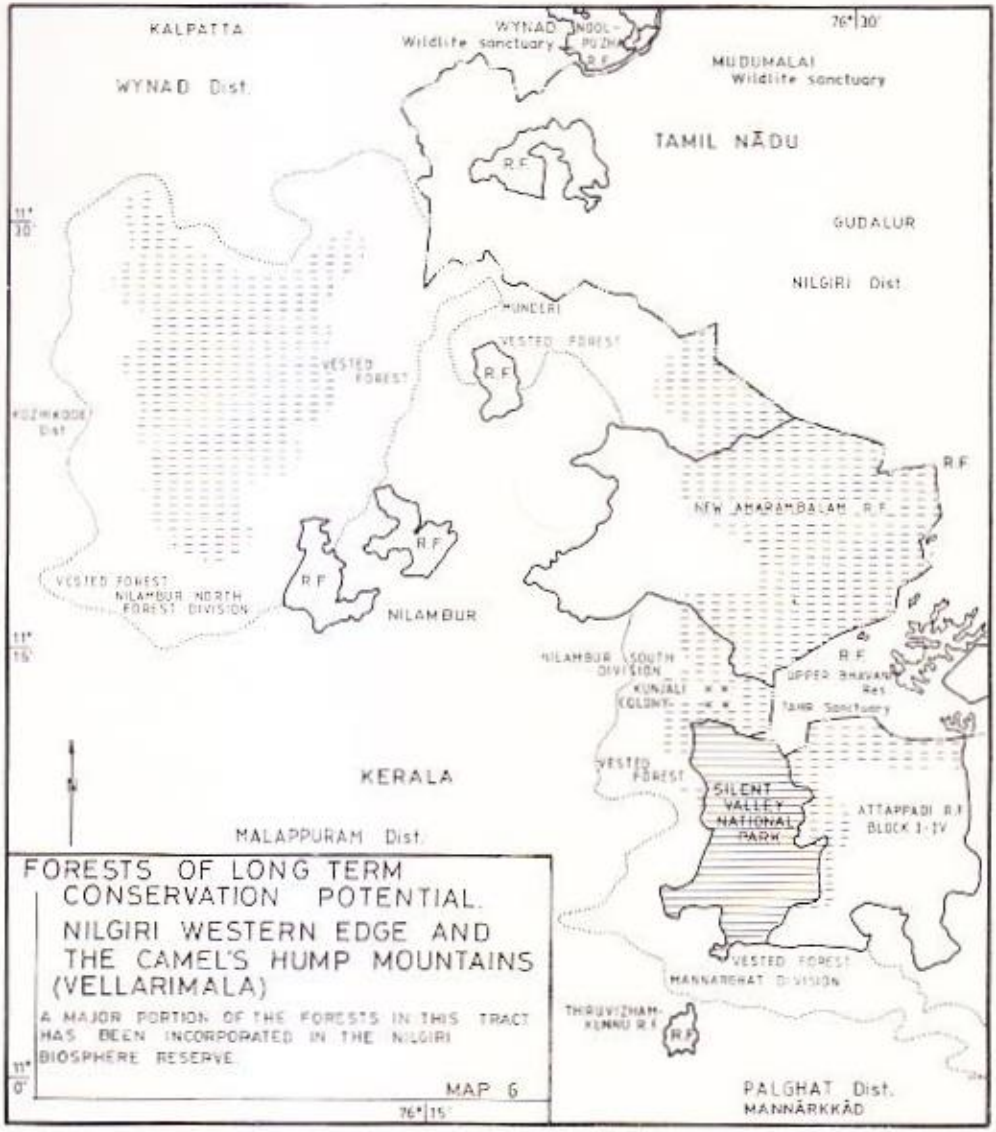

FORESTS OF LONG TERM CONSERVATION POTENTIAL.
NORTHERN HIGH RANGES,
POOYANKUTTY VALLEY AND THE
ANAMALA-NELLIYAMPATHY JUNCTION
MAP 3
KERALA
PALGHAT Dist.
TAMIL NĀDU
TOP SLIP
ALIYAR Res.
PERUVĀRIPALLAM Res.
THŪNAKKADAVU Res.
TAMIL NĀDU
INDIRA GANDHI (ĀNAMALAI) WILDLIFE SANCTUARY
AMARAVATHY Res.
PARAMBIKULAM
PARAMBIKULAM WILDLIFE SANCTUARY
TEA ESTATES
VĀLPARAI
CHINNAR
CHINNAR WILDLIFE SANCTUARY
SHOLAYĀR Res.
UPPER SHOLAYAR Res.
ĀNAMALA R.F.
KOODAKĀDU R.F.
MARAYOOR
ĀNAMALA
ERAVIKULAM NATIONAL PARK
ĀNAMUDI R.F.
KERALA
VATTAVADA
POOYANKUTTY VALLEY
THOOTAYANKETTU Barrage
MUNNĀR
KANNAN DEVAN CONCESSION LANDS
(TATA TEA ESTATES)
TAMIL NĀDU
IDUKKI Dist.
KERALA
MALAYATTOOR R.F.
TODUPUZHA R.F.
77°00
77°15


FORESTS OF LONG TERM CONSERVATION POTENTIAL
SOUTHERN RIM OF PALGHAT GAP
MAP 4
VAZHANI Res
PEECHI Res
PALAKKAD Dist
CHULLIYAR Res
POTHUNDI Res
VESTED FOREST
NELLIYAMPATHY R.F.
MANGALAM Res
PEECHI-VAZHANI WILDLIFE SANCTUARY
VESTED FOREST
CHIMONY Res
PARAMBIKULM WILDLIFE SANCTUARY
CHIMONY WILDLIFE SANCTUARY
KODASSERI R.F.
TRICHUR Dist
PORINGALKUTHU Res
SHOLAYAR Res
MALAYATTOOR R.F.
10° 45'
10° 30'
IDAMALA Res
IDUKKI Dist
BHOOTATANKETTU Res
TATTAKKAD BIRD SANCTUARY
ERNAKULAM Dist
NELLIYAMPATHY HILLS
PEECHI-VADAKKANCHERRY HILLS
CHALAKKUDY AND PERIYAR VALLEY FORESTS
76° 15'
76° 30'
76° 45'



FORESTS OF LONG TERM CONSERVATION POTENTIAL.
NORTHERN RIM OF PALGHAT GAP
(PĀLAMALA, SIRUVĀNI HILLS, SILENT VALLEY, ATTAPPĀDY AND NILGIRI WESTERN EDGE)

MAP 5

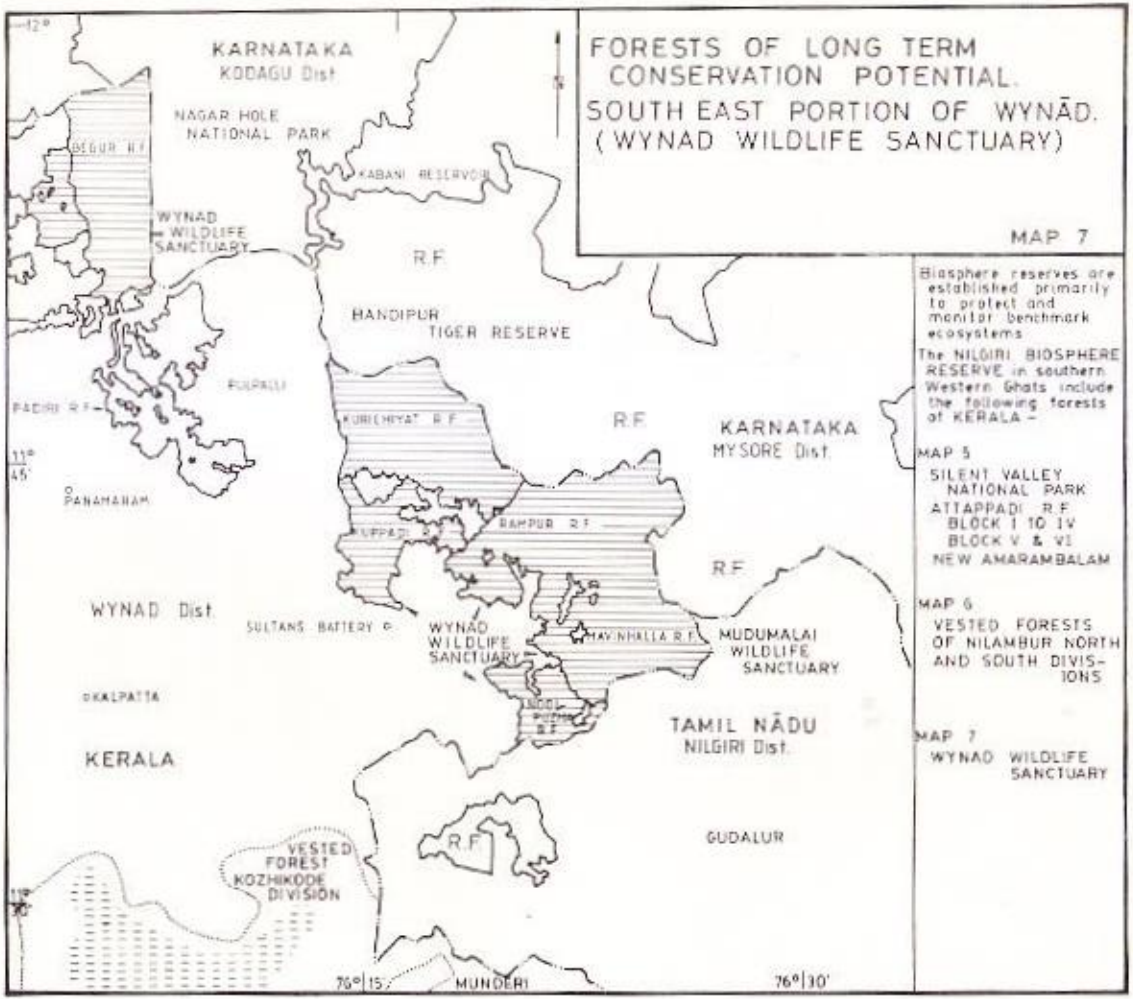


FORESTS OF LONG TERM CONSERVATION POTENTIAL.

NILGIRI WESTERN EDGE AND THE CAMEL'S HUMP MOUNTAINS (VELLARIMALA)

A MAJOR PORTION OF THE FORESTS IN THIS TRACT HAS BEEN INCORPORATED IN THE NILGIRI BIOSPHERE RESERVE.

MAP 6


FORESTS OF LONG TERM CONSERVATION POTENTIAL.
SOUTH EAST PORTION OF WYNĀD.
(WYNAD WILDLIFE SANCTUARY)
MAP 7
KARNATAKA
KODAGU Dist
NAGAR HOLE NATIONAL PARK
BEGUR R.F
KABANI RESERVOIR
WYNAD WILDLIFE SANCTUARY
R.F
BANDIPUR TIGER RESERVE
PUDUPALLI
PADUVA R.F
KURICHIYAT R.F
R.F
KARNATAKA
MYSORE Dist
11° 45'
PANAMARAM
KUPPADI
RAMPUR R.F
R.F
WYNAD Dist
SULTANS BATTERY
WYNAD WILDLIFE SANCTUARY
MAYNHALLA R.F
MUDUMALAI WILDLIFE SANCTUARY
KALPATTA
KERALA
TAMIL NĀDU
NILGIRI Dist
R.F
GUDALUR
VESTED FOREST KOZHIKODE DIVISION
11°
76° 15'
MUNDERI
76° 30'
Biosphere reserves are established primarily to protect and monitor benchmark ecosystems
The NILGIRI BIOSPHERE RESERVE in southern Western Ghats include the following forests of KERALA –
MAP 5
SILENT VALLEY NATIONAL PARK
ATTAPPADI R.F
BLOCK I TO IV
BLOCK V & VI
NEW AMARAMBALAM
MAP 6
VESTED FORESTS OF NILAMBUR NORTH AND SOUTH DIVISIONS
MAP 7
WYNAD WILDLIFE SANCTUARY


FORESTS OF LONG TERM CONSERVATION POTENTIAL.
WESTERN SLOPES OF WYNĀD AND THE BRAHMAGIRI HILLS
MAP 8
KERALA
KARNĀTAKA
KODAGU Dist.
R.F.
VESTED FOREST
NAGAR HOLE NATIONAL PARK
BRAHMAGIRI WILDLIFE SANCTUARY
KANNOOR Dist.
WYNAD WILDLIFE SANCTUARY
KUDRAKOD R.F.
TIRUNELLI R.F.
HILL DALE R.F.
KOTTIYOOR R.F.
PEGUR R.F.
PERAVUR
ARALAM WILDLIFE SANCTUARY
KAMBAMALA R.F.
TRISSILERI R.F.
KANNAVAM R.F.
MANANTHAVADY
PADIRI R.F.
PERIYA R.F.
NADAPURAM
KOZHIKODE Dist.
KERALA
WYNAD Dist.
PANNIKKOTTUR MALAVARAM R.F.
LADY SMITH R.F.
KALPATTA
PERUVANNAMOOZHI
VYTHIRI
75°45'
76°00'

3. The scrub (with plants less than five metre in height and less than 10 percent tree cover).

The changes in vegetation within the reserved forest boundaries are distinguished only in between these three categories. In Kerala, of the remaining natural forests, a major portion is the climax forest type, i.e. the wet evergreen, the canopy density of which is far more than 40 percent and tree height 40 to 50 metres. This climax vegetation, due to human interference, degrades to a variety of sub-climaxes over varying periods of time, which will become apparent only over a longer study. From the point of view of species diversity, the richest evergreen forest degrading to semi-evergreen or moist deciduous forest is almost as destructive as the total forest denudation. As the degradative pressure is still continuing, the sub-climaxes will undergo further rapid degradation. In other words, what may appear as close canopy vegetation over most of the remaining forests of the Kerala Western Ghats is not a viable ecosystem. Similarly, the conservation of an evergreen climax forest into a cardamom plantation does not appear as deforestation, either on a map or on a remote sensing imagery because, at least initially, the canopy remains intact. But from an ecosystem point of view, a cardamom plantation without the lower two strata of plants, which also include younger recruits of canopy trees essential to keep the system alive, is a doomed system.

The earlier study of Chattopadhyay (1985) estimates the original forest cover of 1905 and 1965 on the basis of the Survey of India maps. The survey maps show the boundaries of reserved forests, but not of private forests or common lands under forest vegetation, except in the case of extensive tracts which are then marked as 'dense mixed jungle', etc. The very significant extent of wild plant communities thus lost cannot be brought out by this method. But this loss is significant not only from the point of low of biological diversity, but also from the effect this loss has on local ecosystems, and also on the rural economy. Apart from these, a totally unaccounted for fact in Kerala is the distribution of different forest types influenced by topography which differ in their susceptibility to degradation. The spatial area of forest lost and the ecological value of the area do not correspond. In time, even if the total area lost in unit time has been reduced, the ecological value of forest lost has only increased.

In the earlier period, the forest lost due to the expansion of agriculture was on the ecologically less vulnerable plains and river valleys, and they were of the moist deciduous type with less species diversity and fewer endemics. What is lost later is from the ecologically sensitive higher slopes of the ghats. The forests were of the more fragile evergreen type, with considerably more species diversity and a greater percentage of endemics. The role of these evergreen and shola forests in catchment area protection and climatic amelioration is also critically important.

A study on the reduction in the spatial area of forests cannot bring out such susceptibilities. Moreover, as the total area of forests remaining gets reduced, the

pressure on the remaining area increases in geometrical proportions rather than correspondingly, and the speed with which degradation takes place accelerates rapidly.

Apart from the scientific, ecological aspects of deforestation, there is also the political, socio-economic and other extraneous influences, which cannot be quantified, but which modify the rate of deforestation.

While some data regarding shrinkage in area of forest cover is becoming available, an ecological evaluation of vegetation systems including the wide range of degradative stages of forest types distributed over a variety of topography has not been attempted so far.

In the earlier phase of deforestation, ecologically sensitive lowland forests along the foothills of the Western Ghats and on the hillocks in the midlands, were cleared for cultivation. Although in the second phase climax evergreen forests above 900 metre elevation was cleared extensively for coffee, tea and later cardamom plantations, the relative damages of these two cannot be compared. In every watershed in the Western Ghats of Kerala, the existing grasslands which were areas cleared and abandoned, which reverted to grasslands, originated during this phase. The original area cleared for coffee and the current extent of grasslands do not correspond. In the third phase, extensive moist deciduous forests along the foothills, outer slopes and lower plateaux were cleared for forest plantation (e.g. teak). In the fourth phase, river valley projects and such developmental measures came to the southern Western Ghats. Although a large number of dams were constructed at the base of the ghats for irrigation reservoirs, their impact was much less disastrous, relatively, than in the case of hydel reservoirs constructed on the higher plateaux of around 900 metre evelation. In Kerala 52 dams and barrages were constructed, of which only six did not affect forests directly. But the 28 constructed in the wet evergreen forest zone caused wide ranging and serious repercussions. Some of these dams in the Periyar basin were constructed after the original forest cover had been lost through encroachment. But in all other instances, the dams, reservoirs, powerhouses, colonies, roads, transmission lines and the follow-up encroachments had a far reaching degradative influence on the surrounding vegetation, which could not be classified as outright deforestation. But the retrogression of succession in such forests, creation of savannah vegetation in previously closed canopy forest areas, etc. which human activity entailed, and which even now continues, caused far more ecological 'deforestation' than the area directly submerged under the reservoirs or cleared for the project activity.

The fire degradation of all the remaining forests of Kerala is so insidious that at the current rate of damage, all climax islands of vegetation, with few exceptions, would be retrograded by the turn of the century. Unless high resolution studies are carried out repeatedly even within the same year, the extent of the impact cannot be ascertained. And unless such data is obtained for a sufficient length of time, the magnitude of damage cannot be impressed upon the policy makers or the public.

6.2 Forest fragmentation

In the sequential process of ecodegradation of forests—which, in other words, is the loss of biological diversity, stability and productivity of forest ecosystems—fragmentation of the extensive forests into smaller segments is one of the first major steps. In the process of deforestation, forest fragmentation is both a cause as well as a consequence. When in a forested area a belt of vegetation is cleared, e.g. for an electricity transmission line, the two segments remaining on either side of the deforested area are in consequence fragments of the earlier whole. Similarly, the very clearance results in such drastic edaphic, in particular micro-climatic, changes that if there are climax ecosystems remaining on either side, they undergo drastic degradative changes as a consequence.

Forest fragmentation is defined here as the separation of forested areas by non-forest areas, where the land use practices are opposed to the natural reestablishment of forest vegetation. Fragmentation could also be the establishment of subclimaxes or seral stages which separate climax systems, but at the same time they themselves are arrested stages in the succession which do not proceed to the climax.

The impact of forest fragmentation varies depending on the type of vegetation affected, the specific location and its topography, bioclimate, plesio-climax vegetation, degree of fragmentation and the events that follow the initial fragmentation.

6.3 Conservation of biological diversity and forest fragmentation

Fragmentation of forest may be evaluated from the ecosystem point of view. Survival of species which depend on that particular ecosystem in invariably affected by the fragmentation of ecosystems and the consequent changes. Fragmentation of the biotic community, of the species population and habitat range for a particular species are different levels at which fragmentation may be evaluated as affecting the biological diversity. When dealing with the preservation of species, forest habitat fragmentation assumes considerable importance. It is difficult to generalise the diverse consequences since its effect varies for different forest types, plant communities, different species populations, etc. For a particular location, in a particular habitat, the relative importance of what actually constitutes fragmentation varies from species to species. For a herd of elephants, even a wide reservoir might not constitute a barrier. But for a troop of lion-tailed macaques, the submersion of a valley under a reservoir could constitute a very effective fragmentation of habitat, as well as fragmentation of species population. The clearance of a kilometre wide stretch of forests for teak plantations may not prevent herds of elephants from ranging across it. But if the clearance is for settled agriculture and settlers with firearms move in, it can effectively fragment the elephant population as well as elephant habitat. Sufficient expanse of grasslands can isolate populations of evergreen plants with seeds of limited dispersal capacity which require the shade and moisture of evergreen habitat.

Long-term survival of all ecosystems, communities and species populations depends

critically on the extent of fragmentation. Whether considered from the size of gene pools or from the point of view of optimal utilization of habitat, this is true. The more composite and larger the habitat, the greater the chances of long-term survival of species communities and ecosystems.

The perimeter of a forest, where human interactions are maximum, suffers the highest degree of degradation. In particular, climax vegetation such as the wet evergreen forest has a better chance of retaining its characteristics as a large composite unit than as a number of smaller areas, which may cumulatively add up to the other larger extent. As the size of the area decreases, the surface (perimeter) of interaction proportionately increases, resulting in more widespread degradation.

Any strategy for the long-term conservation of biota, at any level, should take into account the extent of existing degradation before choosing areas for priority action. Planning for conservation must attempt to pinpoint potential threats of fragmentation, identify the causes, formulate preventive measures, as well as corrective measures where fragmentation has already occurred. A regional conservation strategy naturally will have to identify locations where habitat continuity is being threatened as well as locate potential areas for re-establishing corridors where fragmentation has already happened in valuable ecosystems.

6.4 Fragmentation of forests in Kerala Western Ghats

The forests along the Western Ghats extended uninterrupted from the northern to the southern end and extended down, in particular on the western side, almost up to the sea shore till very recently. The cleared areas or settlements were few and scattered widely and, in comparison with the extent of forests, small. Even in Kerala, which is among the most densely populated parts of the country, dense forests survived at least in certain areas almost up to the coastal tract till the 1940s. The Palghat Gap, which is a complete discontinuity in the ghats, was also thickly wooded. The now almost dry areas in the Palghat gap, such as Alathur, Kollangod, Nenmara and Chittoor were rich teak bearing forests of the Cochin State at the beginning of the 19th century. The Palghat plains had many scattered hillocks with dense vegetation even in 1971, when they were nationalized along with other private forests and cleared for distribution among the landless. By the middle of the 19th century, the Palghat Gap had become the first major forest discontinuity in Kerala Western Ghats, with the laying of the arterial communication systems from east to west by the British. Now, for at least a width of 30 km, forests have been pushed back along the Palghat Gap. The way forest fragmentation occurred in Kerala shows the significant influence of topography. As population expanded and extended along the valleys eastward, clearing forests in the process, the smaller isolated hillocks in the midlands became the 'pocket reserves'. As further population expansion resulted in greater degradative influence, these pocket reserves became savannah or scrub land, which in turn were

released for cultivation during the war period.

The Second World War was a crucial juncture in the fragmentation of forests in Kerala, particularly due to the advent of jeeps and other motor vehicles. Roads were necessary for the vehicles to ply. More than the mere width of vegetation cleared, with the rugged topography of the Western Ghats, the extensive network of roads cut up the vegetation along the hill slopes very severely.

After the roads came the river valley development during the fifties, sixties and the seventies. The dams, reservoirs, associated network of roads, electricity and telephone lines, power houses, pockets of settlements, encroachments, tribal cultivation, cash crop plantations, forest plantations of species such as teak, eucalyptus, wattle, pine, etc. in monocrop, seriously fire-damaged forest areas, over exploited and degraded forests, etc. contributed substantially to the fragmentation of the Western Ghats forests in Kerala, to an extent inconceivable fifty years ago.

6.5 Choice of areas for long-term conservation

Before any attempt is made to conserve the exceptionally rich biological diversity in the state, it is necessary to identify viable large islands of forest vegetation which are not under immediate threat of further fragmentation. Hence an attempt was made to identify such contiguous forest tracts through the study of Survey of India maps and documents of the State Forest Department and through intensive field work.

At present the approximately 500 km long north-south stretch of Western Ghats in Kerala has forests cut up into six very distinct regions of distribution. Of this some have only a large number of very small patches of forests scattered over an extensive area, which are under considerable degradative pressure. Very vulnerable attenuated links remain in between some of these regions, while between others the connections have been severed so recently that it is possible to reestablish corridors for floral and faunal exchange.

The nine distinct segments of forests remaining are:

6.5.1 *Forests of the Agasthyamalai*

This is among the most compact of the forested tracts surviving in southern Western Ghats. Although very attenuated in some places, there is an intact climax vegetation along the crestline of the ghats from one end to the other end extending from the southern boundary of the state to the Aryankavu pass in the north. Forests of Trivandrum and Tenmala (part of the area) divisions come within this region. There are three wildlife sanctuaries already notified from within this tract. Moreover, contiguous on the eastern side there is at least double this area of forests falling within two wildlife

sanctuaries in Tamil Nadu. There is about 500 sq.km of administrative forest area in this tract, of which less than 100 sq.km is totally undisturbed climax vegetation.

6.5.2 *Forests of the Pandalam Hills*

Almost contiguous with the first, there is a much larger tract of forest extending from the Aryankavu Pass north to the Kambam Valley-Kumily-Vandiperiyar-Peermade-Mundakkayam axis. The belt of forest along the eastern higher ranges are practically intact. Forests of part of Thenmala Division, the entire area of Konni, Ranni and the Periyar Tiger Reserve and a small part of the Kottayam Division fall within this tract. Of the approximately 1800 sq.km of administrative forest area here, about 500 sq.km are undisturbed primary vegetation.

6.5.3 *Forests of the Idukky and the Cardamom Hill region*

This is a region where forests have been practically totally destroyed, with only a few small islands of vegetation of uncertain viability surviving. There are a number of scattered pockets of 'forests', less than 10 to 15 sq.km each in area, along the western edge of the High Ranges. The largest of such fragments occur in between the two arms of the Idukky reservoir. Some of the remaining small pockets of better preserved shola forests are scattered along the eastern parts of the Cardamom Hill Reserve. Parts of the Kottayam Forest Division, parts of the Kothamangalam Division and the entire Munnar Division fall within this area. There is one notified wildlife sanctuary covering the earlier mentioned larger segment of forests. Although the total administrative forest area is quite large, excluding areas like the Cardamom Hill Reserve and encroachments, forests remaining cover less than 250 sq.km and intact area is insignificantly small.

6.5.4 *Forests of the High Range and Idamala-Pooyankutty Valleys*

A large contiguous forest belt extends all along the northern end of the High Ranges and the southern end of the Anamalais and continues west across the Pooyankutty and Pichchiyar valleys and north up to the Idamala Valley. To some extent this forest is contiguous with an equal extent of forest across the border in the Anamalais of Tamil Nadu. The north-eastern part of this tract is high elevation shola grassland area, where the forests are specialized vegetation in small pockets, restricted to the hill folds. Forests of part of the Munnar Division, Malayattoor Division and part of the Kothamangalam Division are in this tract. The proposed Pooyankutty Hydro-electric Project will cause very serious disruption of this contiguous forest. Forest area in this segment covers approximately 1000 sq.km of which less than 200 sq.km would be closed canopy climax forests. Approximately 100 to 125 sq.km area is relatively undisturbed shola grassland area.

6.5.5 *Forests of Nelliampathies*

Almost contiguous with the former segment of forests, across the Idamala reservoir, another extensive forest tract continues northward up to the Palghat gap. It also extends west, down to the midlands of Trichur. Although extensive in area, a very large number of lease areas, dams, roads, etc. fragments the contiguity of the climax vegetation. Chalakkudy, Vazhachal, Parambikulam, Trichur and Nenmara Forest Divisions are in this segment. With an administrative forest area of more than 1500 sq.km, intact natural vegetation here hardly amounts to 250 sq.km in a number of scattered pockets.

6.5.6 *Forests of the Palghat Hills, Nilgiri west slope, Wynad western slopes and the Brahmagiris*

There is a long attenuated stretch of forest starting from the northern edge of the Palghat gap and extending all the way north to the Brahmagiri range along the Karnataka border. During the last twenty years this belt has been further thinned and broken in a number of places, and is in imminent danger of further fragmentation in many more places.

Sub sections of it are:

A. PALGHAT HILLS :

North of the Palghat Gap forests start from the rim of the gap and extend as a narrow belt along the state border and continue skirting the western edge of Attappady, enclosing some forests on the Palamala-Siruvani Hills. Along the western edge of Attappady the belt of forest is extremely attenuated and is practically broken in at least two points which are possible to be relinked.

B. NILGIRI WESTERN SLOPES :

The forest belt then continues north along the Silent Valley, broadens, skirts along the western scarp of Nilgiris, and then around the head of Nilambur Valley to the south Wynad slopes. This stretch is called the Nilgiri west slope forests and is the most compact and extensive stretch with potential for long-term conservation.

C. CAMEL'S HUMP MOUNTAINS :

The vegetation continuity is again broken in at least two locations at the head of the Nilambur Valley. It can be reestablished through corridors. At the southern parts of Wynad, in the Camel's Hump Mountain again the belt of vegetation broadens and this forest is linked up with the forests along the Nilambur Valley head.

There is altogether about 1500 sq.km of forests in these three sections together, of which about 450 sq.km in four distinct segments are undisturbed. Forests of Palghat and Nilambur North and South divisions, Palghat Special Division, Nilambur Special Division and parts of Calicut and Wynad Special Divisions fall in this segment.

D. WYNAD

Similar to Idukky and the High Ranges, Wynad is another part of the Western Ghats of Kerala where the forests have been very badly fragmented. The earlier mentioned forests of the Camel's Hump Mountains are in tenuous connection with the Nilambur forests and again with the Wynad western slope forests. The western slope forests although very attenuated and broken in four distinct locations skirts around the entire west and north face of Wynad and continues along the face of Brahmagiris in the Cannanore District. The forest cover on the Western Ghats of Kerala end practically with the Aralam forests. The Brahmagiri slope forests also extend towards south-east into the Wynad Plateau almost up to the Pulpally discontinuity. There are a few scattered very small pockets of forests on the northern and western part of the plateau. Along the state border on the eastern edge of Wynad, there is a highly degraded belt of forests stretching part of the way. Excepting the forests on the Camel's Hump Mountains, the remaining forest area in this part of the Kerala Western Ghats would extend over approximately 1000 sq.km, of which less than 200 sq.km in at least 4 segments, would be fairly intact forest.

CHAPTER SEVEN

The History and the Current State of Nature Conservation Areas in the southern Western Ghats of Kerala

7.1 Evolution of the concept of ecosystem conservation and the existing models for achieving it

Current global conservation strategy envisages the setting up of a grid of biosphere reserves for the preservation of benchmark areas of all the ecosystems of the world. The continuous monitoring of these areas, it is hoped, will enable us to understand the dynamics of the living mantle of planet Earth. But apart from the natural benchmark areas, the extensive man-modified landscape also needs a closer scrutiny, since our methods of natural resources utilization through agriculture, animal husbandry, forestry, etc. are all in need of long-term monitoring and evaluation for improving their efficiency. Hopefully, with improved means for using the biosphere, there will be a better chance of survival of species, communities and ecosystems which are senselessly, and often avoidably, destroyed by need and greed. The intact benchmark areas as yardsticks of natural processes, side by side with monitored examples of landscapes currently being used by people, enable us to assess the efficiency of our land management. Some of these cultural landscapes are stable and will provide us with an insight into managing those areas which are being used sub-optimally or destructively. The integration of these three types of areas spatially close together or apart into the frame work of a biosphere reserve is the design blueprint for conservation action as it stands today.

This comprehensive approach has a long evolutionary history starting with species conservation efforts, initially of species identified to be of cultural, aesthetic, commercial or recreational value. Often enough, commencing from the private hunting reserves of the nobility, it had evolved into wildlife sanctuaries, national parks, wilderness areas, gene sanctuaries, marine reserves, world heritage areas, etc. Simultaneously in many instances, microcultures have survived with a different worldview and had

harmoniously integrated themselves with their habitat, and the threat of mutual destruction was never an issue. But such instances over the years have become very rare exceptions as cultural homogeneity has erased different world-views with 'progress'.

As the disruption of the web of life as a consequence of human action became more and more obvious, the vanishing wildlife of the prairies and the deserts, the last lingering members of whales and predators, the extinction of insignificant species of biota and the dying of the oceans has caught the conscience of man. Attempts to protect species through operations such as the 'Project Tiger' not only made us understand the need to protect entire ecosystems, in which the concerned species is only a component, but also showed us our ignorance of the dynamics of ecosystems. Ecosystem conservation efforts, in turn, led us to realize the inter-linkages between ecosystems and the need for a broader framework for global conservation action. The global ecological crisis posing a threat to the very survival of all life in this planet should force us to take radical corrective action in every sphere of our existence.

In our country and in particular in the southern Western Ghats, taking cognisance of these large dimensions is yet to take place at the level of social leadership. And attempts to evolve counter-measures, even as plans, are yet to commence among at least those who perceive the grave situation.

The ecological characteristics of the Western Ghats in Kerala do not make it a large mammal paradise like the Kanha meadows or the East African Savannahs. The terrain is forbidding and forests extremely dense. Even those animals that are present are hidden by the foliage. There are no massive congregations of migrant avifauna as in Bharatpur or Point Calimare. Shikar was not the pastime of the nobility, and hence there were no hunting reserves. Hunting of wild game for meat was not prevalent (the emphasis being more on the easily available fish). The hill forests were vast and an inaccessible world apart. The settled countryside had not lost most of its wild flora or even fauna, excepting perhaps tiger, the large herds of elephants and gaur. The only wild animal which was considered exploitable was the elephant, for domestication, and use in ornamental, religious functions and as a status symbol. Trapping was by the pit method and only a few forest land owning local rulers indulged in it.

Even the coastal tract, which was settled earliest and had a high population density, supported extensive and a practically saturating mosaic of indigenous vegetation islands. The sacred groves or the 'sarpa kavus' for worshiping snakes which preserved islands of littoral and lowland evergreen forests was an important component of the landscape mosaic. In these culturally protected true nature reserves owned by the community, even the dominant canopy trees of the rain forest survived and in sufficient numbers spread over a unit area to be genetically viable populations. The hedgerows and common lands, along with the sacred groves, helped preserve practically the entire biological diversity of the coastal and midland regions of the state. The crop

systems and the cultivation practices almost exactly simulated the stratified structure of natural vegetation, retaining without disruption the micro or the local climate, which in turn guaranteed the survival of the more sensitive smaller biota even in the cultivated lands.

7.2 Conservation after destruction—The colonial period

The situation started deteriorating extremely rapidly from the middle of the 19th century with the arrival of European planters. These adventures and fortune seekers invariably came with guns in hand and dreams of fortunes to be made from the colonies. They laid bare the previously virgin evergreen forests in the ghats for plantations, and wildlife was reduced to stuffed trophies.

At the same time, it must be mentioned that this period also saw the pioneering (and for many areas even today the only) authoritative accounts of flora and fauna. Extensive painstaking collections and systematic cataloguing became the life's mission for a handful of those first wave of European pioneers to reach the southern Western Ghats. Frank Bourdillon, Fyson, H.S. Ferguson, John Stewart, etc. are some of those who have contributed substantially to the natural history of this region.

This advent of guns and the concept of cash crop plantation in hill areas were oppotunities quickly adopted by the 'natives' too, and this changed the face of the ghats. But even then, although the endless stretch of impenetrable evergreen forests extending across the hills and values had become a thing of the past, wildlife was not severely endangered, nor all habitats threatened.

The disappearance of wildlife, at least in some places, did not go unnoticed. One of the first tracts in the southern Western Ghats to be totally deforested for tea plantations were the hills due east of Kottayam, along the Kanjirapally, Mundakkayam, Peermede belt. Many of the planters in this area who were also shikaris grew concerned over the alarming decline of wildlife even as early as 1920–25. It was due to their efforts that the Travancore Government notified the **Nellikkampatty Game Reserve** in 1934 on the banks of the Periyar Reservoir. F.E.H. Robinson was the first game warden. Thus one of the first reserves in India was established in Travancore.

But even earlier in the Kannan Devan Hills, at the northern end of High Ranges, in the lands leased to J.D. Monroe by the Poonjar Raja in 1877, the 77 sq.km Eravikulam Plateau around the Anamudi Peak was set aside as a hunting reserve by the Kannan Devan Hill Produce Company primarily for the ibex, a misnomer for the Nilgiri tahr (*Hemitragus hylocrius*). While due to the outstanding efforts of Robinson, the Nellikkampatty Game Reserve around the Periyar Lake became the premier protected wildlife habitat in this part of the country. The protection given to the Eravikulam Plateau by the Kannan Devan Company saved perhaps the most enchanting landscape in peninsular India and the world's largest congregation of the endangered species of the mountain goat, the Nilgiri tahr.

The Second World War changed the situation radically for the worse. The insatiable need for timber for the war effort led to the opening up of all workable forests. D.D.T. vanquished malaria at least temporarily. Jeeps made roads necessary and along the roads man was able to reach every part of the ghats. Jeep roads soon became lorry roads. The number and quality of firearms improved. In the name of growing more food with government encouragement, settlements sprang up in interior forests. As hardwood stands were wiped out, plywood demand increased. All evergreen forests, previously left untouched, were opened up for working the softwood. After the war years, river valley projects and settlements sprang up all over the hills. The introduction of eucalyptus and, later, wattle (*Acacia dealbata*) drew men up to the till then lonely grassy ridge tops, the last haven of wildlife in the southern Western Ghats. There was no other place for them to retreat.

7.3 The post-Independence period—Increasing awareness of the need to conserve wildlife

In 1950, the **Periyar Wildlife Sanctuary** was notified. It covers an area of 777 sq.km enlarging the Nellikkampatti game reserve, and is the most extensive in the state even today. There had been practically no other step in the protection of flora and fauna of the region excepting this since 1934. The Indian Board for Wildlife was constituted in 1952. After the disappearance of extensive invaluable forest tracts immediately after the states reorganization, in 1958 the next two wildlife sanctuaries were declared in Kerala, namely, the **Neyyar** and the **Peechi-Vazhani** sanctuaries. Since the beginning of the Second Five Year Plan, river valley development became an established concept, and dams were built across the length and breadth of the Western Ghats.

Unlike in other parts of the country, in Kerala, forests and settled areas are clearly segregated by topography. Forests were all in the hills, and the midlands and the sea coast were for settlements. Irrigation dams are feasible in Kerala only at the base of the ghats and the hydro-electric dams up in the plateaux and valleys in the mountains. In either case, forests had to be destroyed. The establishment of the game sanctuary at Nellikkampatti had opened up previously unthought of possibilities. In the very difficult terrain with dense forests, swarming with leeches, snakes, elephants (at least in the public imagination) and other animals, no ordinary traveller would take risks and venture in. On the other hand, from the comfort and safety of a boat, viewing unspoilt scenery and wild animals became an attractive option. In a culture where travel was previously only for pilgrimage and not for pleasure, the western concept of tourism as a form of recreation was being grafted. Dams, reservoirs, boating, tourism and nature preservation were rolled into one.

The threat of dams opening up previously inaccessible valley forests, and encroachers moving in along with the dam, was also being slowly understood from the experience

of Peruniar and Muthirapuzha hydroelectric schemes in the Periyar river in the High Ranges, at project locations such as Ponmudi, Kallarkutty, Pallivasal, Senkulam, etc. As a countermeasure, declaring the forests around project areas as wildlife sanctuaries, with the additional attraction of tourism development, must have been sufficient bait for political decision makers to accept the forest department's efforts to protect these forests. But unfortunately, no further steps beyond the declaration of wildlife sanctuaries have been taken in most areas.

The sixties and seventies were years of forest plantation development. More than 20 percent of the natural vegetation of the state was cleared during this period for plantations of teak and eucalyptus. Although a considerable portion of the plantations were along the lower slopes and river valleys, which would otherwise have been encroached upon, or given away for agriculture by willing governments, some unpardonable forest destruction and annihilation of ecologically valuable wildlife habitats were also perpetrated. The history of Parambikulam was one such.

The Parambikulam Plateau along the southern margin of the Palghat Gap forms a large natural amphitheatre draining towards the south-west, with the backdrop of the Nelliampathies towards the north-west and north, and the Anamalais to the north-east and east. It was one of the best wildlife habitats along with Wynad in the whole of southern Western Ghats. It had a variety of habitats, extensive ecotone areas, safety for the animals as human habitations were far away, plenty of water and forage. Although the area had been heavily worked using the tramway linking it with Chalakkudy, the wildlife had not been drastically decimated. Deforestation gradually reduced the contiguous extensive forest tracts around the Parambikulam Valley; in particular the large scale tea plantations of Valparai and Anamalais along its south-eastern border and the more recent coffee and cardamom plantations along the Karappara Valley towards the north-west. This denudation resulted in an exceptional concentration of wildlife being driven into the central basin of Parambikulam. Starting from the late fifties, three dams came up in the heart of the valley—the Parambikulam, Thunakkadavu and Peruvarippallam, and 10 other dams immediately outside the enclosing hill ranges. Simultaneously, the remaining forests around the dams were all clearfelled and converted to monoculture of teak plantations extending over 10,000 hectares, mostly in Kerala and some in Tamil Nadu. The massive destruction of wildlife this entailed indirectly through habitat destruction and directly through poaching was on a scale till then or never again to be matched. In particular the taungya contractors, using crop protection guns, undertook a massive slaughter. Soon the best wildlife area and congregation of the entire spectrum of Peninsular Indian wildlife was destroyed. The aftermath of this destruction was that in 1973, the **Parambikulam Wildlife Sanctuary** now extending over 285 sq.km, was constituted. It is contiguous with the eastern Anamalai Wildlife Sanctuary of Tamil Nadu.

Simultaneously, in a different location, but in a very comparable process, massive

destruction of habitat and wildlife and posthumous canonisation of the area was taking place. This was in Wynad which is in so many ways similar to Parambikulam. Gently undulating terrain, wide variety of habitats, ecotonal areas, plentiful water and forage, rich herbivore population, which in turn supported a rich carnivore population, and vast contiguous habitat were characteristic of the Wynad plateau. In both the areas there were more of moist deciduous forests suitable for the large mammalian herbivores such as elephant, gaur, sambar, spotted deer, etc. Both Wynad and Parambikulam were also crucial parts of a complex and varied, habitat range needed for the species for survival round the year. The Kerala Wynad was the dry season habitat for large congregations of wildlife from the drier parts of Mysore plateau, northern Nilgiri slopes, Moyar valley, etc. Movement in the reverse direction took place when rains were heavy in Wynad. Similarly in Parambikulam Valley, during the dry season westward movement of animals from the drier Tamil Nadu areas into Kerala takes place. And animals move in the reverse direction during the South West Monsoon period. Hence, there is all the more reason to protect these two areas within a larger, regional wildlife protection and management task.

Though Wynad forests were already being worked for timber, when the British took over the area the intensity of exploitation increased rapidly. Plantations of teak were raised on a small scale by the end of the 19th century. But it was the advent of coffee which shattered the mantle of forests over Wynad, during the latter part of the 19th century. The large-scale inflow of population during and after the Second World War finished off most of the plateau forests, except the drier tract along the state border to the east and the very wet area on the western slopes. Gradually, the huge stretch of forests extending from the Coorg mountains across the Kabini river, and along the edge of the Mysore plateau, over the Kerala Wynad up to and around the Nilgiris and even beyond to the Biligirirangan mountain ranges was being extensively cleared and broken up affecting the seasonal movement of wildlife. The forests adjoining the south-eastern side of Kerala Wynad in the old Mysore State had become a wildlife sanctuary in 1941, and later became the Bandipur National Park. The forests along the north-eastern corner of Wynad, across the Kabini in Karnataka, became the Nagarhole National Park in 1955. At the opposite end, in the south-eastern corner across the state border in Tamil Nadu, Mudumalai in the Gudalur-Wynad region was declared a Wildlife Sanctuary in 1940.

During the hectic forest plantation raising years, most of the remaining reserved forests of Wynad had been converted into teak and eucalyptus plantations, which had seriously upset the carrying capacity of the complex of ecosystems whose boundaries do not follow the state boundaries. With the large-scale settlement of Wynad, among the last of which was the outright encroachment and destruction of the 20,000 acre Pulpalli forests belonging to the Pulpalli temple along the Kabini river adjacent to both Bandipur and Nagarhole, the wildlife in the adjacent states started suffering

habitat reduction. In particular this inter-state complex of Mudumalai, Bandipur and Nagarhole Sanctuaries and adjacent forests in Wynad, which was a prime elephant habitat in peninsular India (its population of elephants is among the largest congregations of wild elephants in India) started getting decimated by poachers primarily from Kerala when the herds moved into this state. In 1973, 'Project Tiger' was started and Bandipur became one among the initial nine project reserves. Kerala-Wynad became an exposed, very vulnerable flank of the Bandipur Tiger Reserve. As a consequence 344 sq.km of area along the eastern parts of Wynad, along the state border, in two segments separated by the Pulpally encroachments were notified as the **Wynad Wildlife Sanctuary** in 1973.

Even earlier, in 1971, the Kerala Government took over the Eravikulam Game Reserve from the Kannan Devan Hill Produce Company, along with all their surplus lands. In 1972 it became Kerala's fourth wildlife sanctuary. In 1983, it was elevated to a National Park's status—the **Eravikulam National Park.**

The massive hydroelectric project on the Periyar River was taken up for construction in 1966. The prolonged construction period of this dam (which incidentally submerged 64 sq.km of river valley forests) was the death knell for the forests along the central High Ranges. Most of the wildlife of this tract had been decimated earlier in the waves of encroachments. Associated with the project activity, huge labour townships sprang up. The consequent degradation and fire damage and fragmentation of forests due to the reservoir, roads, power lines, etc. associated with the project activity had almost wiped out all forests south and west of the main Periyar river, from Vandipperiyar in the south to Neriamangalam in the north. After the completion of the Idukki Hydroelectric Project, almost as a symbolic measure, 70 sq.km of land in between the two arms of the reservoir was notified as the **Idukky Wildlife Sanctuary** in 1976.

In 1982, the preliminary notification for declaring the Periyar Wildlife Sanctuary as a national park was issued, as Periyar had become a tiger reserve being included in the Project Tiger. But the second notification actually elevating Periyar to the status of a national park has not been issued until now.

Travancore-Cochin was one of those areas in the entire subcontinent which has been intensively explored ornithologically. Apart from the wide-ranging collections of the early European planter naturalists, Dr. Salim Ali had carried out two extensive expeditions in this part of the southern Western Ghats since the thirties. One of the areas where he had observed an exceptionally rich avifauna was a place known as Thattakkad at the north-west corner of the High Ranges, at the base of the ghats where the main Periyar river comes out of the mountains and meets with its tributaries Pooyankutty Ar and Idamalayar. Thereafter, the river becomes a placid stream with sand bars and rocky reefs in its wide channel, with riparian forests along the banks grading into moist deciduous, semi and wet evergreen forest towards the east. Although the river bed is less than 30 metres above sea level, dotted about in between the three

river channels there are isolated steep rocky ridges reaching upto 600 metre elevation. This region had an exceptional variety of biotopes in the low country, not to be found anywhere else in Kerala. And nearby were the high elevation hill ecosystems also. Dr. Salim Ali had suggested the declaration of this area as a sanctuary in particular for its bird life. He repeated the plea during the sixties and again in the early seventies during his visits to Kerala. Finally in 1983, 25 sq.km of this area was notified as the **Thattakkad Bird Sanctuary**. But meanwhile Thattakkad had become a major area for forest encroachment. Vegetation continuity had been disrupted in many places. The Bhoothathankettu barrage across Periyar for irrigation had impounded waters which had submerged the original riparian vegetation. Plantations of teak, rosewood, rubber, etc. had replaced natural vegetation extensively, in particular along the river margins. Incidentally, during the gradual degradation of Thattakkad, in the north, around Peruvannamoozhi dam, at the base of the Wynad ghats in the Calicut district, trees were being planted in a totally degraded and deforested area to attract birds in the **Peruvannamoozhi Bird Sanctuary** which is not a notified sanctuary.

Wildlife Sanctuaries have come to be associated with dams and reservoirs in Kerala. It is partly true that most of the dams came up in rich forest areas and accessibility was enhanced by the waterspread area which made wildlife viewing easier. It would have been perhaps justifiable if the notified wildlife sanctuaries in the catchment areas of reservoirs resulted in better protection and management of the forests, and also the reinforcement of the protective role of forests in watershed, which would have safeguarded the huge monetary investment in the river valley projects. Apart from notifying the sanctuaries, in none of the areas was any effective protection or management provided. On the other hand, due to the enhanced accessibility resulting from the construction of the dam, extensive clearfelling and conversion of areas into forest plantations were carried out.

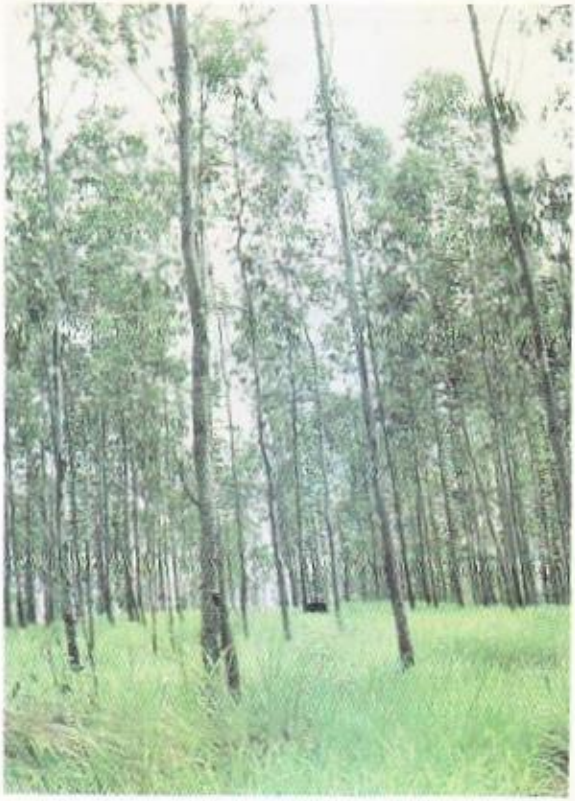
In 1983, the dam under construction across the Karamana river in the forests of Trivandrum Forest Division at the base of the Agasthyar peak was completed, impounding waters for supplying drinking water to the Trivandrum city. Meanwhile most of the forests in the lower reaches of the catchment even along the very margin of the reservoir, altogether extending over 3000 hectares, were clear felled for raising eucalyptus plantations by the Kerala Forest Development Corporation (KFDC). In 1983, 53 sq.km of the watershed of the dam was declared a wildlife sanctuary—the **Peppara Wildlife Sanctuary**—which along its southern border is contiguous with the Neyyar Wildlife Sanctuary and towards the east across the state border with the Mundanthurai Wildlife Sanctuary of Tamil Nadu.

The early eighties were the most important period in the unfolding story of nature conservation in Kerala. The Silent Valley controversy opened a Pandora's Box of questions on forests. The public resistance to the destruction of the rain forests of the Silent Valley Reserved Forest for the proposed hydroelectric project, the attention

focussed on the endemic and rare lion-tailed macaque (*Macaca silenus*) etc. created considerable heated debate in the media and wide ranging public interest was drawn to it. Basic issues in conservation philosophy, specific issues such as status of rain forests, etc. were being debated on a global level also. Naturally, world attention was drawn to the Silent Valley controversy. In 1983, in a hypocritical compromise gesture the Government of Kerala notified the Silent Valley National Park covering 80 sq.km of the reserved forests but excluded the 890 hectares of the submergible core of the valley. But finally, on the basis of scientific opinion and public pressure, the decision which was left to the late Prime Minister, Indira Gandhi, went against the implementation of this project. Accepting this decision the State Government abandoned the scheme and the entire reserved forest was notified as the **Silent Valley National Park** in March 1984.

The year 1984 was unique in more than one way. In that year, four wildlife sanctuaries and one national park were notified in the state. Apart from the Silent Valley National Park, the sanctuaries notified were: **Chenduruny** around the Kallada Irrigation Reservoir in the Quilon District; **Chimmony** around the Chimmony Irrigation Reservoir in the Trichur District; **Chinnar** in the dry deciduous forest tract of Anjanad Valley in the Idukky District; and **Aralam** in the vested forests of Cannanore District in the Brahmagiri slopes, including part of the adjacent Kottiyoor Reserved Forest.

The Chenduruny Valley in the Kolathupuzha Reserved Forest falling partly in the Trivandrum District and partly in the Quilon District was one of the best wet evergreen forests in the whole of the Western Ghats. It was the lowest reaches of the wet evergreen forest belt in the Western Ghats, where primary evergreen forest occurred at an elevation of less than 120 metres above sea level. This part of the Agasthyamalai range has a number of species of plants and lower animals not found elsewhere. The name of the valley, Chenduruny in Malayalam is the name of a tree—*Gluta travancorica*—restricted to this one location. Middle elevation reaches of the Chenduruny Valley were opened up in the coffee boom period in the mid 19th century. But most of the estates were abandoned soon after. And the gaps in the forest canopy created in these areas were colonised by reeds (*Ochlandra*). The Chenduruny Valley became the primary reed collection area for the Punalur Paper Mill. The Travancore Plywood Industry, a government company established in 1943, had its softwood requirements mostly met from this reserve. The contiguous lowest reaches of the Kulathupuzha reserve was leased out and clearfelled for raising rubber plantations for the Rehabilitation Corporation (2265 hectares) in which Sri Lanka repatriates were settled. Whatever lower reach forests remained were converted to eucalyptus plantations by the Kerala Forest Development Corporation for the public sector Hindustan Paper Corporation's newsprint factory at Velloor. All these drastic manipulations led to the degradation of the lower reaches of the Kulathupuzha Reserved Forest, including the Chenduruny Valley. But the interior and upper reaches were pristine forests. In 1969, for the

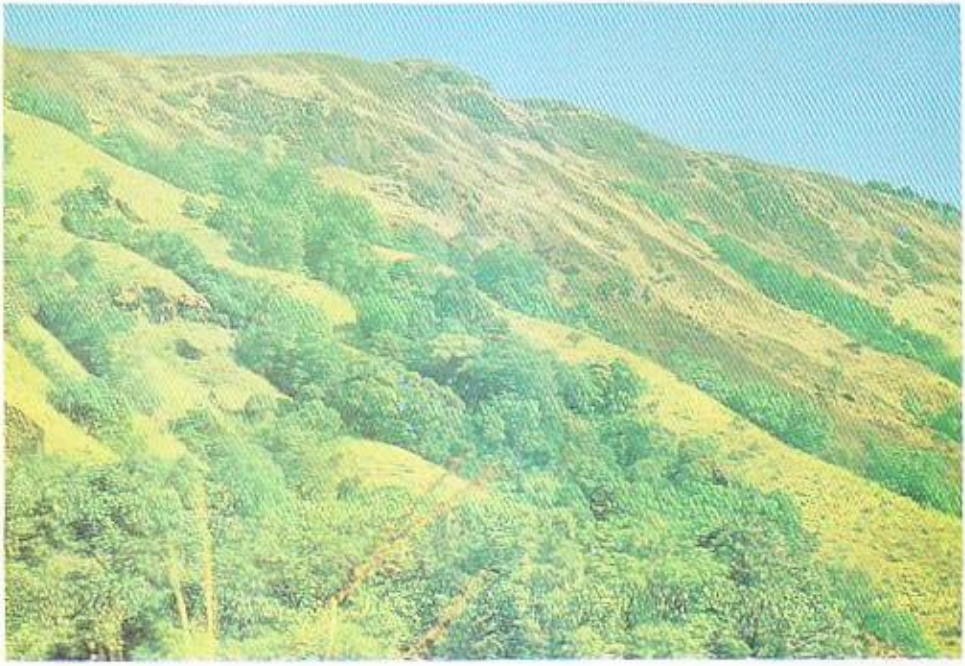


After independence monoculture plantations of industrial species started replacing natural forests. (Eucalyptus plantation, Trivandrum Forest Division)

To raise plantations of cash crops on a commercial basis through public sector corporations extensive reserved forest areas were clear-felled. (Oil Palm India Ltd. plantation, Punalur Forest Division)

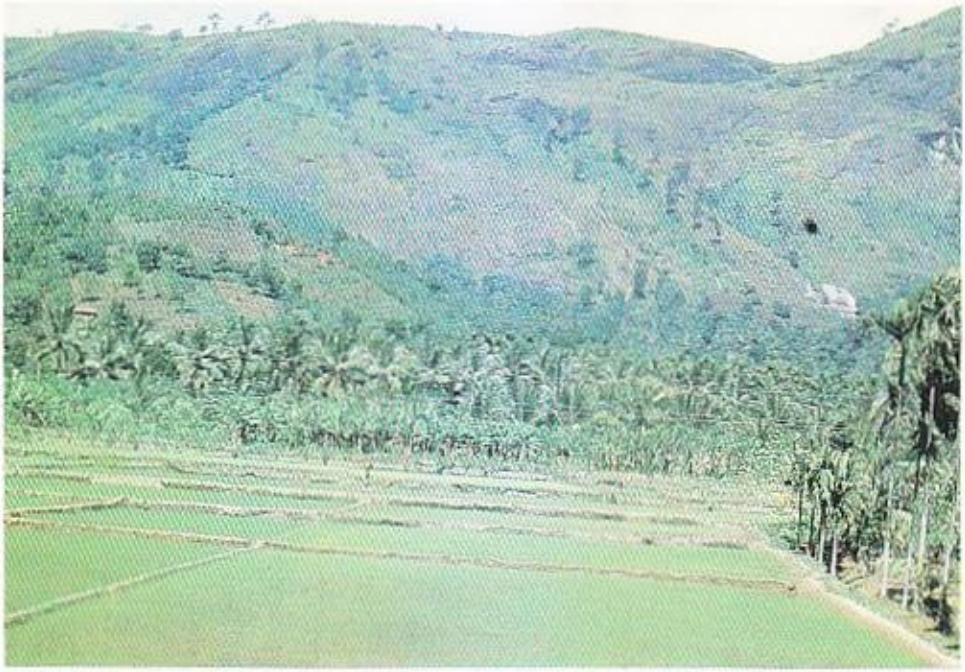
The evergreen forests, especially those subjected to selection felling, suffered severe fire damage. (Sholayar Forest)

Recurrent man-made fires have wiped out primary evergreen forests, turning ridge tops to grass banks. (Thirunelli Reserved Forests)



Many rich evergreen forest stretches along the lower river valleys were submerged by reservoirs of river valley projects. (Chenduruny Valley submerged by Kallada Irrigation Reservoir)

Recent settlers fail to sustainably manage the ecosystems. Deforestation, soil erosion and land degradation follow rapidly. (Siruvani Hills)



Massive encroachment into reserved forests on steep slopes with heavy rainfall laid waste extensive areas. (Malayatoor Reserved Forest)

Many heavily wooded areas were totally denuded within a short time by complex interactive human interference. (Attapady Plateau)

Kallada Irrigation Project, construction of a dam commenced across Parappar. And this resulted in the clearfelling of about 24 sq.km of forests of the Chenuruny Valley, which would have been submerged under the reservoir. As the dam construction was considerably delayed the clearfelled area was leased out to the State Farming Corporation for raising sugar-cane. Encroachments into the area also took place immediately. Finally when in 1984, the dam was plugged, it started leaking and the commissioning of the scheme was put off. The distributory canal system has not been completed even now, nor is it expected to be in the near future. So the clearfelling of the forests in 1969 remains essentially unnecessary even now. In 1984, 100 sq.km of the remaining forests in the catchment of Chenduruny was declared a wildlife sanctuary. In spite of all the past damages, the forests remaining in the sanctuary could very well be among the richest in biological diversity in the southern Western Ghats. Towards the east, across the state boundary, the Chenduruny forests are contiguous with the **Mundanthurai Wildlife Sanctuary** in the upper reaches of Servalar. These forests belong to the unique evergreen type, the Thirunelveli semi evergreen forest (2A/C3) type of Champion and Seth, found only on the eastern slopes of the Western Ghats. Practically the entire area is biologically even now unexplored.

The Chimmony Valley in Trichur district, on the western outer slopes of the Nelliampathies, was a rich deciduous forest tract. But the area had been worked extensively in the past. When the Chimmony-Mupply irrigation scheme was taken up for execution, the valley of Chimmony River in the submergible area of the reservoir was slated for clearfelling. In 1984, the remaining catchment area of the reservoir was declared a wildlife sanctuary covering 90 sq.km. It adjoins the Peechi-Vazhani Wildlife Sanctuary to the north. The western edge of the Parambikulam Wildlife Sanctuary is separated from it by a narrow densely forested corridor of the Kodassery Reserved Forest. The **Chimmony Wildlife Sanctuary** could very well, with adequate protection, conserve a benchmark area of the most endangered forest type in Kerala—the south Indian moist deciduous forest (the *Tectona-Dillenia-Lagerstroemia lanceolata-Terminalia paniculata* series of Gadgil-Meher-Homji classification (Ref. 4.4.2)).

The Marayoor Forest Range in the Munnar Division on the eastern side of the highest reaches of the High Ranges have the only dry deciduous sandal bearing forests in Kerala (the *Terminalia-Anogeissus latifolia-Tectona* series). These forests in the Anjanad Valley, starting from the lower reaches along Amaravathy, at an altitude of less than 300 metres, rapidly ascend to elevations greater than 2500 metres, along the eastern border of the Eravikulam National Park. In 1984, 90 sq.km of forests in this tract, covering the widest transect of vegetation types, altitudinal and bioclimatic zones, was declared a wildlife sanctuary. This is the only wildlife sanctuary in Kerala with extensive dry deciduous vegetation. This sanctuary, called the **Chinnar Wildlife Sanctuary**, has along its north-eastern border across the state boundary the Anamalai Wildlife Sanctuary of Tamil Nadu, and along its north-western corner, it adjoins the

Eravikulam National Park. It has the only known population of the grizzled giant squirrel *Ratufa macroura* in Kerala, which is perhaps the rarest mammal in Peninsular India, after the Malabar Spotted Civet (which is believed to be extinct).

Beyond Wynad (north of 12°N latitude) the evergreen forests of Western Ghats show characteristic changes in vegetation, partly due to climatic reasons and in particular due to the longer rainless period. Though the evergreen ghat forests of Wynad and Brahmagiris are floristically rich, distinct from the *Cullenia-Mesua-Palaquium* series, and included in the *Dipterocarpus-Mesua-Palaquium* Series of Gadgil-Meher-Homji classification no representative area of this vegetation type was included in any wildlife sanctuary till 1984. The Aralam forests on the Brahmagiri slope in Kerala, in the Cannanore district, are practically the northern limit of forests on the western slope of the ghats in the state. Part of the remaining vested forests in Aralam, and the higher reaches of the adjacent Kottiyoor Reserved Forest, which had been heavily worked through selection-felling were constituted into a 55 sq.km wildlife sanctuary in 1984. Detailed studies are warranted to ascertain its conservation value. This is a part of the Western Ghats, where practically no biological surveys have been conducted.

7.4 Contribution of existing protected areas towards the conservation of biological diversity

Kerala has at present two national parks, totalling 166 sq.km in area—the 77 sq.km of high elevation shola-grassland ecosystem of Eravikulam and the 89 sq.km wet evergreen forests of Silent Valley. In Silent Valley, excluding the grassland and areas heavily damaged during 1974–'83 period, about 45–50 sq.km of fairly undisturbed vegetation remains in the upper reaches. The 777 sq.km, Periyar Tiger Reserve, which should have been a national park with the issuing of the second notification has, apart from the waterspread area of the reservoir, extensive eucalyptus plantations in the grasslands and vast stretches of fire-degraded savannah vegetation. Only less than 300 sq.km of minimally modified climax vegetation survives in this reserve.

In the 344 sq.km of Wynad Wildlife Sanctuary, there is no pristine area of vegetation. The not too severely degraded and compact area of natural forest in this sanctuary would extend over hardly 30 sq.km, since most of the area has already been converted to plantations. In the 285 sq.km of Parambikulam Wildlife Sanctuary, hardly 35–40 sq.km of evergreen forests along the western and southern border, a section of the Kariyan shola and a few scattered islands of moist deciduous forests on hill tops (amounting to less than 20 sq.km in total which were also worked in the past) remain as potential areas for conservation of biological diversity. In the 128 sq.km Neyyar Wildlife Sanctuary, fairly undisturbed forests remain only as one fragmented strip along the crestline of the highest ridge, totalling less than 30 sq.km, which continue further north into the 53 sq.km Peppara Wildlife Sanctuary. In the latter, hardly 20 sq.km

of this high elevation evergreen forests remain intact. In the Peechi-Vazhani Wildlife Sanctuary, out of the 125 sq.km area, hardly 25 sq.km along the south-eastern border are the better preserved moist deciduous forests. These continue further south along the western outer slopes of the Nelliampathies, into the Chimmony Wildlife Sanctuary, occupying about 30 sq.km of the 90 sq.km area of the sanctuary. Out of the 100 sq.km area of Chenduruny, at least 50 sq.km are valuable climax forests. While in Chinnar, out of the 90 sq.km area, only 10–15 sq.km of shola-grassland ecosystems adjoining Eravikulam remain undisturbed. About 35–40 sq.km of the lower reaches of forests in the sanctuary, badly degraded as they are, are the only dry deciduous forest area in Kerala and hence warrant preservation as part of the spectrum of vegetation types in the Western ghats of the State. Practically the entire area of Eravikulam is undisturbed shola-grassland ecosystems.

In the Idukky Wildlife Sanctuary, most of the 70 sq.km area is open savannah, created through fire degradation of closed forests with only a few pockets of residual evergreen forests remaining. There is hardly 20 sq.km of currently undisturbed savannah woodland and pockets of closed forest surviving in this sanctuary at present.

In the 55 sq.km Aralam Wildlife Sanctuary about 30 sq.km of evergreen forests remain as potentially valuable area. Practically the entire 25 sq.km of Thattakkad has been too severely degraded.

Thus, out of the 2328 sq.km of forests constituting the two national parks and 12 wildlife sanctuaries of the state, hardly 750 sq.km area can be considered as near-natural forest ecosystems. This works out to be around 8 percent of the total reserved forest area (as estimated by the resource survey in 1973, to be 9400 sq.km). Out of the sanctuary area in the state, about 300 sq.km are forest plantations mostly in Wynad, Parambikulam, Peechi-Vazhani, Periyar Tiger Reserve, Peppara and Neyyar. These areas are still under routine plantation management and cannot be considered relevant in any ecosystem conservation strategy. Tribal settlements and tribal cultivation areas cover about 20 sq.km area, distributed mostly in Wynad, Chinnar, Neyyar, Peppara and Parambikulam sanctuaries. If the waterspread area of the reservoirs in eight of the sanctuaries are also deducted from the total extent, the 'forest' area in the sanctuaries of the state works out to be less than 1900 sq.km, which is about 20 percent of the official figure given for the total forest area in the state. This is less than 5 percent of the total geographic area of the state. Out of the total 'sanctuary' area, 1150 sq.km are ecosystems in various degrees of degradation, mostly through fire, partly through past over-exploitation and need ecorestoration efforts urgently.

7.5 Biosphere Reserves

In September 1986, the Nilgiri Biosphere Reserve was inaugurated which includes 1455 sq.km of forests of Kerala, including most of the reserved forests in Palghat,

Nilambur and Wynad divisions. This was the considerably delayed beginning of a new phase in the conservation of the biological diversity of the state.

The concept of biosphere reserve emerged from the programme on Man and the Biosphere (MAB). MAB itself was initiated through a resolution passed by the 'Biosphere Conference' convened in Paris by UNESCO "as an inter-government program of research aiming to develop an inter-disciplinary scientific basis for the rational use and conservation of the resources of the Biosphere" (Michel Batisse, 1982). The first official definition of biosphere reserve was given by UNESCO in 1970, where the emphasis was on research and monitoring of representative or otherwise relevant ecosystems. Since then the concept has undergone evolution and interpretations, particularly when put into practice in different countries. The primary objectives of biosphere reserves as codified by the Task Force organized in 1974 by UNESCO are:

a) To conserve for present and future use the diversity and integrity of biotic communities of plants and animals within natural and semi-natural ecosystems and to safeguard the genetic diversity of species on which their continuing evolution depends.
b) To provide areas for ecological and environmental research, including base line studies both within and adjacent to such reserves.
c) To provide facilities for education and training.

The main characteristics of biosphere reserves are defined as follows:

a) Biosphere reserves are protected areas of land and coastal environments; together they should constitute a world-wide network linked by international understanding on purposes, standards and exchange of scientific information.
b) The network of biosphere reserves should include significant examples of biomes throughout the world.
c) Each biosphere reserve should include one or more of the following:
   i. representatives examples of natural biomes;
   ii. unique communities, or areas with unusual features of exceptional interest;
   iii. examples of harmonious landscape resulting from traditional patterns of land use; and/or
   iv. examples of modified or degraded ecosystems that are capable of being restored to more or less natural conditions.
d). Each biosphere reserve should be large enough to be an effective conservation unit and to accommodate different uses without conflict.
e) Biosphere reserves should provide opportunities for ecological research, education, and training: they will have particular value as benchmarks or standards for measurement of long-term changes in the biosphere as a whole.
f) A biosphere reserve must have adequate long-term legal protection.
g) In some cases biosphere reserves will coincide with or incorporate existing or proposed protected areas such as national parks, sanctuaries or natural reserves.

7.5.1 *The Nilgiri Biosphere Reserve*

The Nilgiri Biosphere Reserve launched in September 1986, has a total area of 5520.40 sq.km, extending over the states of Karnataka, Kerala and Tamil Nadu around the Nilgiri Mountains. Out of a total core zone of 1240.3 sq.km, 264.4 sq.km is from Kerala and out of the forestry manipulation zone of 3238.7 sq.km, 94.5 sq.km is from Kerala. In the restoration zone of 706.4 sq.km, Kerala's contribution is 245.9 sq.km. The important forests from Kerala included in the Nilgiri Biosphere Reserve are the entire Wynad Sanctuary, New Amarambalam and Karimpuzha reserves of the Nilambur Division, Silent Valley National Park, Attappadi Reserved Forest and parts of Siruvani Reserved Forest of Palghat Division. It also includes 387.6 sq.km of Nilambur vested forest and about 200 sq.km of Palghat vested forest.

The concept of identifying intact core areas for total protection and monitoring with buffer zones for incorporating land use management concerns of the local population makes it essentially different from the earlier conservation area designs. It is an open concept where human beings and their needs are incorporated.

International co-operative efforts towards this end have been operational since 1976 and the global network today includes 243 biosphere reserves in 65 countries as of 1984. India proposes to set up 13 biosphere reserves of which the Nilgiri Biosphere Reserve is the first to be launched. Unfortunately, since it involves co-ordinated management of forests in three different states, and since at least temporarily, the concerned states stand to lose revenue from some of the forests included in the core zone, there has not been much headway made with this practical and dynamic concept.

APPENDIX

Protected Areas in the forests of Kerala
Status and Vegetation

Neyyar Wildlife Sanctuary

Location : 8°30'N-8°37'N latitude
77°8'E-77°17'E longitude
Revenue district : Thiruvananthapuram (Trivandrum)
Drainage basin : Neyyar River

The catchment area forests upstream of Neyyar Irrigation Reservoir extending over 128 sq.km. including the waterspread area of the reservoir, was declared a wildlife sanctuary on the August 6, 1958.

This sanctuary is contiguous with the Peppara Wildlife Sanctuary in Kerala to the north, and with the Mundanthurai and Kalakkadu sanctuaries in Tamil Nadu towards each across the state border. The forests of this sanctuary range in elevation from 80 metres to 1866 metres above msl.

Located so near the southern tip of the peninsula, with the crestline height of the ghats not exceeding 1500 m, it has moderately heavy rainfall ranging from 1800 mm to 3000 mm. per year with a very short dry season ranging from one to two months only.

Potentially, the major types and subtypes of vegetation (according to Champion and Seth forest vegetation classification) occurring within the sanctuary are:

1. Southern hilltop tropical evergreen forest	1A/C3
2. West coast tropical evergreen forest	1A/C4
3. West coast semi-evergreen forest	2A/C2
4. Pioneer Euphorbiaceous scrub	1A/2S1
5. Southern secondary moist mixed deciduous forest	3A/C2/S2
6. Riparian fringing forests	4E/RS1
7. Myristica swamp forest	4C/FS1

8. Tropical hill valley swamp forest 4C/FS2
9. Reed brakes 8A/E1
10. South Indian sub-tropical hill Savannah (Woodlands) 8A/DS1

There has been heavy disturbance to this sanctuary from a variety of causes which continue even now, which has resulted in extensive areas of climax natural vegetation getting degraded to secondary types. The southern secondary moist mixed deciduous forest in the lower reaches and the south Indian sub-tropical hill savannah (woodland) in the higher reaches are the vegetation types common now. The best remaining vegetation type is the southern hilltop tropical evergreen forest along the crestline of the ghats. This forest is a known type locality for a large number of plant species with extremely restricted distribution. Approximately 25 sq.km of such vegetation survives in a narrow north-south belt along the highest reaches of the sanctuary. There is also a smaller number of scattered pockets of intact west coast semi-evergreen forest along the hill folds and short reaches of riparian fringing forests along the stream margins before they join the reservoir.

The number of scattered tribal hamlets within the sanctuary, which they have been gradually pushed into with extremely unstable agricultural land use practices, severe annual fires which retrograde all types of evergreen vegetation, widespread illicit felling of trees primarily for firewood along the lower reaches and thousands of people traversing the interior forests on pilgrimage to the Agasthyamala Peak are destroying this area invaluable for ecosystem conservation. The absence of an effectively managed buffer belt to absorb the exploitative pressures has permitted all the damaging anthropogenic influences to reach the very core area and destroy it irreversibly.

Peppara Wildlife Sanctuary

Location : 8°34'N-8°42'N latitude
77°7'E-77°15'E longitude
Revenue district : Thiruvananthapuram
Drainage basin : Karamana River

Contiguous with the Neyyar Wildlife Sanctuary which is on its southern border, the catchment area of the Karamana River upstream of the Peppara dam extending over 53 sq.km including the waterspread area has been notified as a wildlife sanctuary on December 21, 1983.

Across the state border, to the east of the Peppara Sanctuary, is the Mundanthurai Wildlife Sanctuary. Its altitudinal range is from 60m to 1717m above mean sea level. The average annual rainfall is 1800–3000 mm with a dry season lasting for only one to two months, as in Neyyar Wildlife Sanctuary.

Potentially, the major types and subtypes of vegetation occurring in this sanctuary are:

1. Southern hilltop tropical evergreen forest 1A/C3
2. West coast tropical evergreen forest 1A/C4

3. West coast semi-evergreen forest	2A/C2
4. Pioneer Euphorbiaceous scrub	1A/2S1
5. Southern secondary moist mixed deciduous forest	3A/C2/S2
6. Reed brakes	8A/E1
7. South Indian tropical hill Savannah woodlands	8A/DS1

Similar to the Neyyar Wildlife Sanctuary, this sanctuary also has floristically valuable locations, such as Chemmunji peak area, from where a number of plants with extremely restricted distribution have been collected earlier. This sanctuary has less than 20 sq.km of intact southern hilltop tropical evergreen forest along the crestline continuous with that of the Neyyar Sanctuary.

The degradative processes this sanctuary is subjected to is as severe as in Neyyar, and are primarily due to a number of scattered tribal hamlets whose agricultural land use has been destabilised, severe annual fire damage, large scale illicit felling of wood and the presence of a tea estate in the very core of the sanctuary close to the most valuable forest. The extensive eucalyptus plantations all along the margin of the sanctuary, their routine working, and the socio forestry planting in grasslands cause considerable disturbance. There is no effective buffer margin for insulating and protecting the remaining intact vegetation.

Chenduruny Wildlife Sanctuary

Location : 8°48'N-8°57'N latitude
77°4'E-77°16'E longitude
Revenue district : Kollam (Quilon)
Drainage basin : Kallada River

Forests in the catchment area of the tributaries of the Kallada river upstream of the Parappar dam, over an extent of 100 sq.km, including the waterspread area of the reservoir, was notified as a wildlife sanctuary on August 25, 1984. It is contiguous across the state border with the Mundanthurai Wildlife Sanctuary in Tamil Nadu and is separated from the Peppara Wildlife Sanctuary in Kerala to the south by a 15 to 18 km wide reserved forest tract. This sanctuary spreads across an altitudinal range of 120m. to 1785m. The average annual rainfall ranges from 2500 mm to 5000 mm and the dry season is one to two months.

Potentially, the major types and subtypes of vegetation (Champion and Seth classification) occurring within this sanctuary are:

1. Southern hilltop tropical evergreen forest	1A/C3
2. West coast tropical evergreen forest	1A/C4
3. Cane brakes	1A/E1
4. Wet bamboo brakes	1A/E2
5. West coast semi-evergreen forest	2A/C2
6. Southern moist mixed deciduous forest	3B/C2

7. Myristica swamp forest	4C/FS1
8. Sub-montane hill valley swamp forest	4C/FS2
9. Riparian fringing forests	4E/RS1
10. Reed brakes	8A/E1
11. South Indian sub-tropical hill savannah woodland	8A/DS1
12. Southern montane wet temperate forest	11A/C1
13. Southern montane wet grassland	11A/DS2

This tract of forests, in particular the lower reaches of Chenduruny, had been worked in the past through selection felling for timber, and reed collection had also been carried out extensively. There are a few enclosures of recent settlements. Although the perimeter of the reservoir and the lower reaches of the earlier worked forests had undergone some degradation, primarily from fire. The upper reaches are well preserved southern hilltop tropical evergreen forests extending over at least 50 sq.km in a composite segment. There are a few well preserved stretches of southern montane wet temperate forest, west coast semi evergreen forest and west coast tropical evergreen forest apart from the various edaphic sub types.

SUGGESTED MEASURES TO ENHANCE THE ECOSYSTEM CONSERVATION POTENTIAL OF THE THREE SANCTUARIES IN THE AGASTHYAMALAI HILL RANGE.

Incorporating an approximately 100 sq.km area in between the Chenduruny and Peppara Sanctuaries falling within the Kolathupuzha, Yerur and Palod reserved forests, would establish a continuous corridor of intact ecosystem along the crestline of the Agasthyamalai Hill Range extending all the way from the southern border of the state to the northern end of Agasthyamalai Hill Range.

The Agasthyamalai range of hills in the extreme southern end of the Western Ghats is the most compact part of the Western Ghats and floristically among the richest. It has about 1300 sq.km of forests falling in Kerala and Tamil Nadu. In Kerala there are about 120–150 sq.km of benchmark forest ecosystems, while in Tamil Nadu more than 250 sq.km remain intact. Total forest area in Kerala is about 450 sq.km, of which 280 sq.km (i.e. 125 sq.km Neyyar, 53 sq.km Peppara and 100 sq.km Chenduruny Wildlife Sanctuaries) have already been notified as sanctuaries. Including the present discontinuity in protected area coverage between Chenduruny and Peppara sanctuaries to an extent of 100 sq.km as part of either of the sanctuaries, a composite invaluable ecosystem preservation zone extending over 380 sq.km can be created.

Already on the Tamil Nadu side, the 530 sq.km Mundanthurai Wildlife Sanctuary and the 250 sq.km Kalakkad Wildlife Sanctuary (the latter to be extended further) form a composite heterogeneous, well protected stretch of southern Western Ghats forest ecosystems.

Periyar Tiger Reserve

Location : 9°16'N-9°36'N latitude
76°57'E-77°25'E longitude

Revenue district : Idukky

Drainage basin : Periyar River

This Wildlife Sanctuary was declared in 1934, initially covering only a part of its current area in the catchment area of the Mullaperiyar Dam in Periyar River. Subsequently, the area was expanded to cover 777 sq.km and on 27 October 1982 the first notification for declaring the area as a national park was issued. It became a tiger reserve in 1978.

The Periyar Tiger Reserve ranges in altitude from 900 m to 2019 m above sea level and the average annual rainfall is between 2000 mm and 5000 mm per year. There are two to three rainless months.

The major vegetation types represented within this protected area are:

1. Southern hilltop tropical evergreen forest	1A/C3
2. West coast tropical evergreen forest	1A/C4
3. Cane brakes	1A/E1
4. Wet bamboo brakes	1A/E2
5. West coast semi-evergreen forest	2A/C2
6. West coast secondary evergreen Dipterocarp forest	2A/2S1
7. Southern moist mixed deciduous forest	3B/C2
8. Riparian fringing forest	4E/RS1
9. Reed brakes	8A/E1
10. South Indian sub-tropical hill savannah woodland	4A/DS1
11. Southern montane wet temperate forest	11A/C1
12. Southern montane wet grasslands	11A/DS2

There are other seral stages and subgroups in particular of the tropical moist deciduous forest occuring within this forest. This protected area is not only the most extensive in Kerala but also includes the largest extent of west coast tropical evergreen, southern hilltop tropical evergreen, west coast semi-evergreen, west coast secondary evergreen dipterocarp forest and southern Indian tropical hill savannah woodland forest ecosystems.

From the point of view of conservation of representative ecosystems in southern Western Ghats, this wildlife sanctuary is at present the best. Out of its 777 sq.km area, at least 300 sq.km in a compact segment and another 50 sq.km scattered in smaller pockets are climax tropical moist forest areas. The degradative pressures, excepting fire along its fringes, gradually reducing the area of intact ecosystem are minimal.

Contiguous with this sanctuary, towards the south and south-west, there is a further 500 sq.km of practically undisturbed forest vegetation in the adjacent Ranni and Tenmala Divisions forming part of the Gudarakal, Konni and Ranni Reserved Forests.

If this composite unworked and uninhabited area can be given the status of a tropical moist forest benchmark area, perhaps the largest compact west coast tropical evergreen forest and southern hilltop tropical evergreen forest area in the entire Western Ghats would be assured of long-term protection.

Eravikulam National Park

Location : 10°8'N-10°19'N latitude
77°0'E-77°8'E longitude

Revenue district : Idukky

Drainage basin : Periyar River and Pambar (Amaravathy) River

The highest reaches of the Western Ghats at the junction of the Anamalais and High Ranges form a high plateau with an average elevation of about 2000 m above sea level with individual peaks going up to 2300 m or more. Part of this high elevation area is in Eravikulam Pl-teau in the Idukky district of Kerala and partly in the Grasshills of the Coimbatore district. The Eravikulam Plateau and the adjacent areas in the High Ranges of Kerala were the lease lands of the Kannan Devan Hill Produce Company. From the middle of the nineteenth century when they acquired the lease, the company protected this area which was unsuitable for tea planting as a game reserve for its population of Nilgiri tahr (*Hemitragus hylocrius*), a species of mountain goat restricted to the southern Western Ghats. The uncultivated lands of the Kannan Devan Company including the game reserve was taken over by the government in 1971 and the 77 sq.km. Eravikulam Plateau declared as a wildlife sanctuary in 1972. It was elevated to a national park status on 28 February, 1978.

The national park area ranges in elevation from about 1000 m to 2695 m above sea level, (the highest point in peninsular India, south of the Himalaya). The rainfall in this area ranges from around 2000 mm to 5000 mm with a dry season ranging from two to three months.

The major vegetation types and subtypes in this national park are:

1. Southern sub-tropical hill forest	8A/C1
2. Southern montane wet temperate forest	11A/C1
3. Southern montane wet scrub	11A/DS1
4. Southern montane wet grassland	11A/DS2

The Eravikulam National Park has perhaps the largest relatively undisturbed high elevation ecosystems in the entire Western Ghats. Most of the area is southern montane wet grassland with extremely small patches of montane wet temperate forests known as 'sholas' restricted to the hill folds.

Being restricted to a few small scattered pockets in a few locations separated from each other by extensive tracts of edaphically unsuitable lower elevation areas, many of the species of plants and animals in these reaches have extremely discontinuous distribution ranges. Hence for the objectives of species preservation, as many shola

areas as possible in the higher reaches of Western Ghats should be protected. Along with the Nilgiris and the Palnis (Kodaikanal Hills) the High Ranges (in particular the Kannan Devan Ranges) has maximum potential habitat. Eravikulam is the only protected area of high elevation (above 1800 m) shola grassland ecosystem in Kerala.

There is, scattered discontinuously over approximately a 1000 sq.km, a tract less than 50 sq.km of shola vegetation in a very large number of small pockets. The largest of them may extend over a few hundred hectares while the smaller ones are miniscule pockets. It is most essential to identify all the potential shola forests and formulate a plan of action to effectively protect them.

Chinnar Wildlife Sanctuary

Location : 10°15'N-10°21'N latitude
77°5'E-77°16'E longitude

Revenue district : Idukky

Drainage basin : Pambar (Amaravathy) River

The Anjanad Valley is one of the three locations in Kerala where the eastern slopes of the Western Ghats fall within the state. Since some of the highest reaches and the broadest streches of the Western Ghats lie immediately to the west of the Anjanad Valley, there is an almost rainshadow effect. Along the eastern edge of the Anjanad Valley, 90 sq.km of forest was declared a wildlife sanctuary on 4 August 1984. The vegetation is mostly dry deciduous in the eastern edges of the valley, but all vegetation types ranging from montane wet temperate forests in the highest reaches of the sanctuary to low elevation vegetation occur in the sanctuary. Along with the altitudinal gradient this sanctuary has also rainfall ranging from 600 mm to 3000 mm and a dry season ranging from three to six months.

The principal vegetation types and subtypes in the sanctuary are:

1. Moist teak-bearing forest	3B/C1
2. Southern secondary moist mixed deciduous forest	3B/C2/2S2
3. Riparian fringing forest	4E/RS1
4. Dry teak forest	4A/C1
5. Dry deciduous scrub	5A/DS1
6. Dry bamboo brakes	5A/2S1
7. Secondary dry deciduous forest	
8. Southern sub-tropical hill forest	8A/C1
9. Southern montane wet temperate forest	11A/C1
10. Southern montane wet scrub	11A/DS1
11. Southern montane wet grassland	11A/DS2

The Chinnar Wildlife Sanctuary is important for ecosystem conservation, not only because it has a wide range of types and subtypes of forest vegetation, but also because it occupies a pivotal position in a larger complex of conservation areas. This tract of

forest is in the hub of a larger extent of forest vegetation extending from the Anamalai Wildlife Sanctuary of Tamil Nadu and the Parambikulam Wildlife Sanctuary of Kerala along the Eravikulam National Park, and southward to the Manjampatty-Kukkal valleys on the north slope of the Palnis and the scattered remnant sholas of the High Ranges.

Although at present, the habitat in the sanctuary is extremely degraded due to a variety of reasons including extensive scattered Muthuva-Malappulaya tribal hamlets, with suitable management measures including incorporating some of the adjacent reserved forests, the maximum range of habitat and forest vegetation types and subtypes could be brought within a protected area.

Parambikulam Wildlife Sanctuary

Location : 10°20'N-10°32'N latitude
76°35'E-76°51'E longitude
Revenue district : Palakad (Palghat)
Drainage basin : Chalakkudy River

The Parambikulam Basin had been well known for its rich forests and wildlife. It was worked heavily during the last century. The Parambikulam-Aliyar River Valley Project and its associated series of dams and other structures came up during the sixties followed by extensive teak plantations extending over almost 100 sq.km of the valley. The extremely disturbed area lost most of its natural vegetation. In 1973, 285 sq.km area of the Parambikulam Valley was notified as a wildlife sanctuary contiguous with the Anamalai Wildlife Sanctuary of Tamil Nadu across the border. This sanctuary area ranges in altitude from 459 m to 1439 m above sea level.

The most important vegetation types which used to occur in the Parambikulam Valley and surrounding hills were:

1. West coast tropical evergreen forest	1A/C4
2. West coast semi-evergreen forest	2A/C2
3. Moist teak bearing forest	3B/C1
4. Southern secondary moist mixed deciduous forest	3B/C2/2S2
5. Riparian fringing forest	4E/RS1

But at present undisturbed stretches of the west coast tropical evergreen and semi evergreen alone remain along the western part of the sanctuary in scattered pockets.

The significance of this sanctuary in protecting the ecosystem diversity of the southern Western Ghats is important only when it is taken into consideration along with the adjacent Peechi-Vazhani Wildlife Sanctuary and the Chimmony Wildlife Sanctuary in Kerala.

Peechi-Vazhani Wildlife Sanctuary

Location : 10°28'N-10°40'N latitude
76°17'E-76°29'E longitude
Revenue district : Thrisoor (Trichur)
Drainage basin : Karuvannur

Along the southern tip of Palghat gap a spurhill range extends north-west from the Nelliampathies separating the Trichur and Palghat districts. Being low hills exposed to the dry Palghat gap as well as the heavy rainfall western side, this tract had a variety of forest vegetation types and subtypes, in particular extensive west coast semi-evergreen and southern moist mixed deciduous forests. During the second half of the fifties two irrigation dams were constructed at either end of this ridge, the south-eastern Peechi Dam across the Karuvannur River and the north-western Vazhani dam across Keecheri River. Subsequently extensive forests from the tract were totally lost and the remaining areas severely degraded. Forests totalling 125 sq.km in the catchment area of Peechi and Vazhani dams were notified as a wildlife sanctuary on 6 August 1958. The sanctuary area extends from 40 m elevation to 928 m elevation above mean sea level.

Excepting approximately 25 sq.km forests along the extreme south-west corner, practically the entire remaining forest vegetation in this sanctuary is too severely degraded to be of value in long term ecosystem conservation.

Chimmony Wildlife Sanctuary

Location : 10°22'N-10°29'N latitude
76°25'E-76°34'E longitude
Revenue district : Thrisoor
Drainage basin : Karuvannur

Along the south-western flanks of the Nelliampathies contiguous with and further south of Peechi an extent of 90 sq.km forest covering the low foot hills and extending east to Parambikulam was declared as a wildlife sanctuary on 25 August 1984. This was subsequent to the commencement of work on an irrigation scheme damming the Chimmony river. The notified sanctuary is the catchment forest of the dam. The sanctuary area ranges in attitude from 50 m to 1116 m above mean sea level.

The principal forest vegetation types and subtypes remaining within this sanctuary are:

1. Southern hilltop tropical evergreen forest	1A/C3
2. West coast semi evergreen forest	2A/C2
3. Moist bamboo brakes	2A/E2
4. Moist teak bearing forest	3B/C1
5. Southern moist mixed deciduous forest	3B/C2

The Chimmony Sanctuary is separated from the Parambikulam Sanctuary to its east by an approximately 15 km wide stretch of forest along the catchment of Kannankuzhithodu in Kodasseri Reserved Forest. If an approximately 50 sq.km area of forests along this tract can be incorporated into the Chimmony, contiguity of protected areas can be established with Parambikulam and intact west coast tropical evergreen forests would add to the diversity of vegetation types in the sanctuary.

The Western Ghats immediately south of Palghat gap is topographically complex extending from the low foot hills of Peechi and Chimmony eastward into the Parambikulam basin rimmed by the Nelliampathy hills and the Anamalais and abruptly descending down to the dry Pollachi-Udumalpet plains in Tamil Nadu. This is among the most heterogenous areas in the entire Western Ghats as far as bio-climatic zones types and subtypes of forest vegetation, endemic species, etc. are concerned. Only by taking into consideration the complex of Parambikulam, Peechi, Vazhani and Chimmony wildlife sanctuaries in Kerala with the adajcent Anamalai Wildlife Sanctuary in Tamil Nadu, the full potential value of this tract can be realized.

The Parambikulam Sanctuary, as it is demarcated at present, includes mostly teak plantations and degraded fragments of natural forests. But just outside the sanctuary boundary there are well preserved and extensive forests in particularly of the west coast tropical evergreen type in the Karapara Valley, Sholayar Valley and along the Nelliampathies. An area of about 150 sq.km of such vegetation should be brought within the Parambikulam Sanctuaries to enhance its value for ecosystem preservation while the existing sanctuary continues to provide the multiple non-destructive benefits.

The 285 sq.km Parambikulam Wildlife Sanctuary with an additional 150 sq.km area, the 90 sq.km Chimmony Wildlife Sanctuary, with an enhanced extent of 120 sq.km, and the Peechi-Vazhani Sanctuary reduced to about 75 sq.km after deleting too severely degraded areas from the existing 125 sq.km, covers an extremely varied and rich mosaic of habitats in the southern Western Ghats.

Adjoining the sanctuary complex in Tamil Nadu the contiguous forest vegetation forms the Anamalaai Wildlife Sanctuary (proposed to be elevated to the status of a National Park) which extends south to the Palni hills on one hand and also links up with Eravikulam National Park and Chinnar Wildlife Sanctuary in Kerala. The Pooyankutty-Idamala river valley forests in Kerala are contiguous with the Anamalai Wildlife Sanctuary. Thus, starting from the Palghat gap all the way south to the Kannan Devan Hills in Kerala, there is forest continuity on the western as well as on the eastern sides of Western Ghats 900 sq.km of forest in this stretch is already included in national park or wildlife sanctuary in Kerala and a nearly equal extent is protected in Tamil Nadu. Adding another 400 sq.km in Kerala, mostly to the west of Parambikulam and in between Parambikulam and Eravikulam to the south-east, corridors of protected areas could help preserve the most extensive ranges of ecosystems in the entire Western Ghats.

Silent Valley National Park

Location : 11°4'N-11°13'N latitude
76°24'E-76°29'E longitude

Revenue district : Palakad (Palghat)

Drainage basin : Kunthipuzha (Bharathapuzha)

The 89 sq.km reserved forests forming the catchment area of Kunthipuzha along the south western slopes of Nilgiris in Kerala was the centre of a major ecological controversy during the first half of the eighties. This controversy was regarding the proposal to construct a hydroelectric dam across Kunthipuzha within the reserved forest. The Silent Valley forests ranging in elevation from 900 m to 2500 m above sea level and getting an average rainfall of 3000 to 6000 mm per year was notified as a national park in March 1984.

The major vegetation types present in the national park are:

1. Southern hilltop tropical evergreen forest	1A/C3
2. West coast tropical evergreen forest	1A/C4
3. West coast semi-evergreen forest	2A/C2
4. Southern subtropical hill forest	8A/C1
5. South Indian subtropical hill savannah (woodland)	8A/DS1
6. Southern montane wet temperate forest	11A/C1
7. Southern montane wet scrub	11A/DS1
8. Southern montane wet grassland	11A/DS2

Silent Valley National Park, along with the Periyar Tiger Reserve, protects some of the best remaining evergreen forests in the southern Western Ghats. But on its own the long term viability of the Silent Valley forests, as well as its potential to preserve the tropical evergreen forest ecosystems, are limited. Lacking adequate buffer belts along its perimeter, with the degradative influence of past damage (in particular fire damage) still affecting the forest adversely, the area can be valuable in ecosystem preservation only as a part of the Nilgiri Biosphere Reserve.

Nilgiri Biosphere Reserve

The Nilgiri Biosphere Reserve inaugurated in November 1986 covers a total area 5520 sq.km straddling the Western Ghats in Kerala, Karnataka and Tamil Nadu, mostly around the Nilgiris. From Kerala approximately 1400 sq.km of forested area is to form part of it. Of the total core area of 1240 sq.km of intact representative ecosystems 264 sq.km forests are from Kerala. Out of the forestry manipulation zone of 3238 sq.km , 94.5 sq.km, and out of a total restoration zone of 706 sq.km, 246 sq.km are from Kerala.

Silent Valley National Park is part of the core zone. The 344 sq.km Wynad Wildlife Sanctuary is the only other existing protected area forming part of the Nilgiri Biosphere Reserve. The Wynad Wildlife Sanctuary is almost entirely forest plantation area or extremely degraded forest areas needing restoration management and, hence, has no value in ecosystem preservation.

Some of the valuable benchmark areas in the southern Western Ghats in particular in the area adjacent to the Palghat Gap and the Nilgiri western slope are incorporated in the biosphere reserve. The Palamala-Siruvani hill forests, the New Amarambalam Reserve and forests of the Camel's Hump Mountains are among these. But unfortunately, some of these areas are designated as forestry manipulation zones. Small and scattered but ecologically rich areas in particular along the Wynad western slopes and northern edge of Wynad plateau, at present not protected, have been left out of the Nilgiri Biosphere Reserve also. On the basis of ground surveys for identification of the current status of these areas, suitable ones should be included in the biosphere reserve core area.

The Aralam Wildlife Sanctuary

Location : 11°53'N-11°59'N latitude
75°46'E-75°56'E longitude
Revenue district : Kannoor (Cannanore)
Drainage basin : Aralampuzha

Forests measuring 55 sq.km falling partly in the vested forests and partly in the Kottiyoor Reserved Forest in the Brahmagiri slopes ranging in elevation from 60 m to 1589 m above sea level were notified as a wildlife sanctuary on 25 August 1984.

This is the only protected area of west coast tropical evergreen forest of the *Dipterocarpus-Mesua-Palaquium* type. The edaphic conditions in this part of the southern Western Ghats are distinct from that of further southern reaches. Less than 25 sq.km of fairly undisturbed forest of this type is included in this sanctuary.

The major vegetation types within the sanctuary are:

1. Southern hilltop tropical evergreen forest	1A/C3
2. West coast tropical evergreen forest	1A/C4
3. West coast semi-evergreen forest	2A/C2
4. West coast semi evergreen Dipterocarpus forest	2A/2S1

Wildlife sanctuaries in Kerala of marginal role in ecosystem preservation

Out of the two national parks and 12 wildlife sanctuaries in Kerala, the 70 sq.km Idukky Wildlife Sanctuary in the Idukky District, along the margin of the Idukky Hydroelectric Project reservoir and the 25 sq.km Thattakkad Sanctuary also in Idukky district close to Bhoothathankettu Irrigation Barrage across Periyar, are too degraded

and isolated areas with no benchmark ecosystems.

Apart from the wildlife sanctuary and national parks, there are a number of isolated, scattered small extents of vegetation communities in the Western Ghat areas or known habitats of species with a relict, restricted distribution. In the effort to protect the entire range of biological diversity, identifying and evolving effective protected mechanisms for such locations also should be given due attention. But the priority for such an effort is secondary in view of the rapid destruction of larger, otherwise viable areas.

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Glossary

Albedo	A measure of the solar radiation which is reflected from the earth's surface and the lower atmosphere.
Anthropogenic	Caused by human actions directly or indirectly.
Arborescent	Resembling a tree in its habits and nature.
Archaean	(Geology, Synonymous with Precambrian). The first great division or era in the timescale in earth's history. Period from 6000–600 million years ago.
Biogeography	The branch of biology dealing with the geographical distribution of living things.
Biotic	Used here to indicate the influence of living things on the environment.
Boreal	Referring to land in the northern parts of the earth where the average temperature is not over 18°C. Boreal forests are forests in such locations.
Butte	A small flat topped hill standing above the adjacent country because of its greater resistance to erosion. It is smaller than a mesa.
Ecotone	A transition zone between two neighbouring communities such as grassland and forest or between two ecosystems such as the land and the sea.
Edaphic	Pertaining to the physical environmental conditions, example soil and soil factors.
Embayment	Any bay, inlet or similar appearing shore configuration by the action of which bay formation takes place.
Endemic	Particular to or restricted in distribution to an area or locality.
Fluvial	Influenced or caused by flowing (water or air) medium, primarily water.
Geomorphology	The origin, development and characteristics of the surface features of the earth.
Gneisses	Goarse grained and banded rocks of igneous or metamorphic origin characterized by the conspicuous dark mineral present.
Horsts	An upthrown area between two parallel faults (a fracture in the rock

along which there has been observable amount of displacement) is a horst. The corresponding downthrown areas adjacent to a horst are called grabens.

Mesa Spanish term for an isolated table-land area with steep sides, the result of a horizontal capping of hard strata having resisted denudation. In the course of time, with the continual erosion of the sides, a mesa is reduced to a smaller flat-topped hill—a butte. Mesas and buttes often occur in groups and may be regarded as a late stage in the dissection of a region of horizontally layered rocks.

Orography Related to mountains, e.g. orographic rains.

Precambrian That period of time from the consolidation of the earth's crust to the base of the Cambrian, i.e. from 6000 million years to 600 million years from the present day. Synonymous with Archaean.

Quarternary period The latest period of time in the geological timescale 1–2 million years to the present day.

Scarp (also escarp) Steep slope; the precipitous face of a ridge of land, extent of rock or a cliff.

Tertiary period The period of geological time between the Cretaceous period to the Quarternary. The period is from 65–70 million years back to the present day.

The Indian National Trust for Art and Cultural Heritage is a wholly autonomous body, set up for the conservation of our natural and cultural heritage. The Society aims, with the active participation of its members, to create an awareness among the public for preservation of this heritage, by acting as a pressure group when any part of it is threatened by damage or destruction arising either out of private acts or public policy.

INTACH will undertake pilot conservation projects; promote the preservation of traditional arts and crafts; organise and facilitate workshops; study courses, conferences and lectures and undertake the publication of a journal, books, pamphlets, newsletters, and so on, in any area relating to conservation.

Dr. Sathis Chandran Nair, an ecologist of eminence, has conducted extensive field studies in the tropical forests of the southern Western Ghats. At present the Director of INTACH's Southern Regional Office at Thiruvananthapuram, he was earlier commissioned by the Ministry of Environment and Forests to study the status of the tropical forests of the southern Western Ghats and also the land capability of the Andaman and Nicobar Islands.

Dr. Nair's holistic study of the virgin tropical rain forests of the Silent Valley played a significant role in saving them from the proposed hydel project. His scientific field study also contributed to the establishment of the Nilgiri and Namdapha Biosphere Reserves.